EVA London 2022

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Editors:
Jonathan P. Bowen
Jon Weinel
Ann Borda
Graham Diprose

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Thanks to all the contributors for making EVA London a continuing success.

Preface

The *Electronic Visualisation and the Arts* London 2022 Conference (EVA London 2022) is co-sponsored by the Computer Arts Society (CAS) and BCS, the Chartered Institute for IT, of which the CAS is a Specialist Group.

Of course, this has been a difficult time for all conferences, with the Covid-19 pandemic. For the first time since 2019, the EVA London 2022 Conference is a physical conference. It is also an online conference, as it was in the previous two years. We continue with publishing the proceedings, both online, with open access via ScienceOpen, and also in our traditional printed form, for the second year in full colour.

Over recent decades, the EVA London Conference on *Electronic Visualisation and the Arts* has established itself as one of the United Kingdom's most innovative and interdisciplinary conferences. It brings together a wide range of research domains to celebrate a diverse set of interests, with a specialised focus on visualisation.

The long and short papers in this volume cover varied topics concerning the arts, visualisations, and IT, including 3D graphics, animation, artificial intelligence, creativity, culture, design, digital art, ethics, heritage, literature, museums, music, philosophy, politics, publishing, social media, and virtual reality, as well as other related interdisciplinary areas.

The EVA London 2022 proceedings presents a wide spectrum of papers, demonstrations, Research Workshop contributions, other workshops, and for the seventh year, the EVA London Symposium, in the form of an opening morning session, with three invited contributors. The conference includes a number of other associated evening events including ones organised by the Computer Arts Society, Art in Flux, and EVA International.

As in previous years, there are Research Workshop contributions in this volume, aimed at encouraging participation by postgraduate students and early-career artists, accepted either through the peer-review process or directly by the Research Workshop chair. The Research Workshop contributors are offered bursaries to aid participation. In particular, EVA London liaises with Art in Flux, a London-based group of digital artists.

The EVA London 2022 proceedings includes long papers and short "poster" papers from international researchers inside and outside academia, from graduate artists, PhD students, industry professionals, established scholars, and senior researchers, who value EVA London for its interdisciplinary community. The conference also features keynote talks. A special feature this year is support for Ukrainian culture after its invasion earlier in the year.

This publication has resulted from a selective peer review process, fitting as many excellent submissions as possible into the proceedings. This year, submission numbers were lower than previous years, mostly likely due to the pandemic and a new requirement to submit drafts of long papers for review as well as abstracts. It is still pleasing to have so many good proposals from which to select the papers that have been included.

EVA London is part of a larger network of EVA international conferences. EVA events have been held in Athens, Beijing, Berlin, Brussels, California, Cambridge (both UK and USA), Canberra, Copenhagen, Dallas, Delhi, Edinburgh, Florence, Gifu (Japan), Glasgow, Harvard, Jerusalem, Kiev, Laval, London, Madrid, Montreal, Moscow, New York, Paris, Prague, St Petersburg, Thessaloniki, and Warsaw. Further venues for EVA conferences are very much encouraged by the EVA community.

As noted earlier, this volume is a record of accepted submissions to EVA London 2022. Associated online presentations are in general recorded and made available online after the conference.

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Rehan Zia

Ode to Hope

Live free or die
Ukraine's cry
for life, liberty, and
the pursuit of happiness
When less
is more
Stop the war
No more – No more

Rivers of tears
flow down the Dnieper
Mother's fears
Children dying
Can't stop crying

Can't believe
The fate of Kyiv
under siege
This hallowed ground
Lost and found
Stop the war
No more – No more

Let freedom ring
Sing – Sing
Sing of life's and love's
eternal spring
Hope is
Everything

— *Tula Giannini* (March 2022)

A ferry over the Dnieper River by Serhiy Svetoslavsky, Ukrainian landscape painter, born 1857 in Kyiv, died 1931 in Kyiv. Painting, 1900s, National Art Museum of Ukraine.
https://commons.wikimedia.org/wiki/File:Svetoslavsky_Ferry_Dnieper.jpg

_____
Live free or die – motto of US state of New Hampshire, adopted 1845.
Life liberty and the pursuit of happiness – The Declaration of Independence, June 1776.
Let freedom ring – Dr. Martin Luther King, Jr., from his "I Have a Dream" speech, 28 August 1963; and "America (My Country, 'Tis of Thee)" patriotic song by Samuel Frances Smith, 1831.

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Digital Art and Identity Merging Human and Artificial Intelligence: Enter the Metaverse

Tula Giannini
Pratt Institute
School of Information
New York, USA
http://sites.google.com/view/tgiannini
giannini@pratt.edu

Jonathan P. Bowen
London South Bank University
School of Engineering
London, UK
http://www.jpbowen.com
jonathan.bowen@lsbu.ac.uk

Chris Michaels
National Gallery &
King's College London
London, UK
https://www.kcl.ac.uk/people/chris-michaels
Chris.Michaels@ng-london.org.uk

Carl Hayden Smith
Ravensbourne University London
London, UK
https://www.ravensbourne.ac.uk/people-and-stories/meet-team/carl-smith
c.smith@rave.ac.uk

This Symposium explores themes of digital art and identity with respect to Artificial Intelligence and the developing ideas of the "metaverse". The paper provides some background to the concept of the metaverse in the context of digital culture. Then each participant provides a statement from their viewpoint and experience. These cover diverse issues based on the varied backgrounds and expertise of the contributors.

Artificial Intelligence. Digital art. Digital culture. Digitality. Identity. Metaverse.

1. INTRODUCTION

This paper records talks for a Symposium of invited speakers at the EVA London 2022 Conference. It continues a series from the previous five EVA London Symposiums held since 2016 (Bowen & Giannini, et al. 2016–2021), which have been supported by the EVA London Conference (Bowen 2020).

The Symposium series initially started in association with the Pratt Institute London Summer School, with an emphasis on digital culture and "digitalism" or "digitality" (Bowen & Giannini 2014; 2021; Giannini & Bowen 2019a; 2019b). A collaboration with the Royal College of Art developed, providing an artistic and philosophical angle to the Symposium. Aspects of digital culture (Giannini & Bowen 2018; 2019a) continue in this year's Symposium, which considers identity with respect to human and artificial intelligence in the sphere of digital art, and especially the advent of the "metaverse". The speakers for this 2022 Symposium come from varied backgrounds, bringing their own perspectives to the overall theme.

2. THE METAVERSE

On 28 October 2021, Mark Zuckerberg announced by way of a burst of television advertisements (Meta 2021) that the parent company of Facebook, Instagram, WhatsApp, Messenger, and the virtual reality company Oculus is now called Meta Platforms Inc. Significantly, the advertisement begins in a museum gallery and zooms in on the jungle landscape of Henri Rousseau's 1908 painting entitled *Fight Between a Tiger and a Buffalo* (see Figure 1 overleaf).

Meta's advertisement incorporates key elements of the widely popular immersive exhibitions, especially Van Gogh. Rousseau's painting is animated and seen through the eyes of engaged children with the implied melding of real and virtual, which in essence defines the immersive exhibition model and aesthetic sense of the metaverse to be – will that be a virtual world somewhere between digital art and Disneyland?

Figure 1: *Fight Between a Tiger and a Buffalo (1908), by Henri Rousseau. The Cleveland Museum of Art. https://commons.wikimedia.org/wiki/File:Henri_Rousseau_-_Fight_between_a_Tiger_and_a_Buffalo_-_1949.186_-_Cleveland_Museum_of_ArtFXD.jpg*

The only five words the advertisement contains, Zuckerberg puts into the mouth of the tiger – "this is the dimension of imagination." So, not information, but human imagination and creativity, from which will be built a new "metaverse reality" (Meta 2021). With digital becoming increasingly embedded in the physical world, and when seeing and being in the metaverse is realised through the digitised human body, from headsets, eyeglasses, watches, body systems to neural networks of the human and artificial brain connecting imagination and creativity, the metaverse gives us new ways of communicating states of being through digital-physical beings as robots, embedding digital systems in physical place and space. One yet to be appreciated result, is the shift away from screens in favour of direct interaction. How will this impact human digital behaviour, when the computer and smartphone, the ever-present intermediaries between humans are augmented with more integrative technology like Virtual Reality (VR) and Augmented Reality (AR)? Will digital communication and interaction become part of a new reality of living between real and virtual worlds?

This means that the field of Human-Computer Interaction (HCI) shifts its focus from human interaction with computers to human-to-human interaction within the framework of computational culture, merging real and virtual worlds, so that human interactions reside more in a simulation of real/physical life. Once the metaverse is in full swing, will life be more akin to video games and a Disneyland-like landscape (see Figure 2)? Will humans become comic-book characters? Will the metaverse be like hell on earth, or heaven in cyberspace, a new Shangri-la – or a simulation of reality, the good, the bad, and the ugly (see Figure 3)?

Cyber Identity **by Tula Giannini**

I feared
you wouldn't come back
Disappeared
or hacked
Lost in cyberspace
No trace
Can't see your face

Send me a text
Let me know
what's next
perplexed
vexed
Is your cyber identity dead
Nothing read
Nothing said

No – No – No
I don't want to let go
Send me a sign
you're still mine
still online
Send me a kiss
A wish
A dream
Last seen
Don't know when
we'll love again

Lost in cyberspace
No interface
Database down
Lost not found
in the metaverse
Is the real story
life in purgatory
Locked down
in the metaverse
For better or worse

Figure 2: *The Metaverse, a man skateboarding towards an imagined future metropolis. Freepic.com. https://www.freepik.com/free-vector/man-skateboarding-future-metropolis_vector_4997265.htm*

Figure 3: *Domenico di Michelino, fresco painting, 1465, of The Divine Comedy by Dante Alighieri in the dome of the church of Santa Maria del Fiore in Florence. Dante holds his great poetic work, The Divine Comedy at the entrance to Hell, the seven terraces of Mount Purgatory and the city of Florence, with the spheres of Heaven above – reminiscent of Starry Night by Van Gogh!* https://commons.wikimedia.org/wiki/File:Dante_Domenico_di_Michelino_Duomo_Florence.jpg

Each participant interprets the symposium theme in the context of their own life and work. Then looking from the present into the future, how has art, identity and human digital behaviour been transformed and what will it mean to be human in a post-Covid, post-digital world (Giannini & Bowen 2021; 2022a; 2022b)?

3. SPEAKER STATEMENTS

Jonathan P. Bowen
London South Bank University, UK

Expo 2020: Metaverse of the World?

The international Expo 2020 exhibition, delayed due to the Covid pandemic, was held in Dubai, United Arab Emirates, from 2021 to 2022 (Expo 2020). It is in itself a "metaverse" of the world with pavilions of 192 countries presenting their national characteristics in any way that they wish, within varying financial restrictions. For example, the United Kingdom pavilion included a display of poetry generated from words supplied by visitors using Artificial Intelligence (AI) techniques (see Figure 4). In contrast, the Italian pavilion included a reproduction of the historic *David* carved by Michelangelo, generated from a very high-resolution digital scan of the original sculpture (see Figure 5). Other displays were more poignant with recent events, such as the Ukrainian pavilion where all electronic displays were replaced with the hashtag #StandWithUkraine.

Expo 2020 has its own associated apps, including a metaverse app paralleling the Expo 2020 site itself in a virtual world (Magnopus 2021). In addition, many of the larger pavilions include large electronic displays using AI, AR, VR, and Mixed Reality (MR) approaches. The presentation covers these aspects in more detail for a selection of pavilions at Expo 2020.

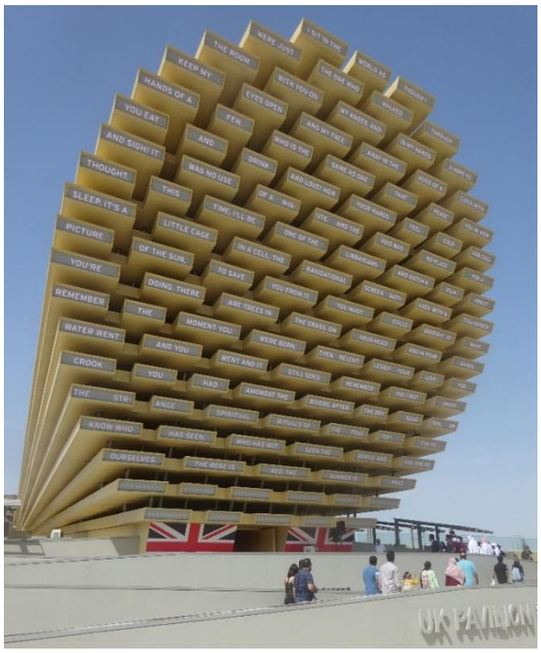

Figure 4: *The United Kingdom pavilion at Expo 2020 with even-changing AI-generated poetry produced from words supplied by visitors.*

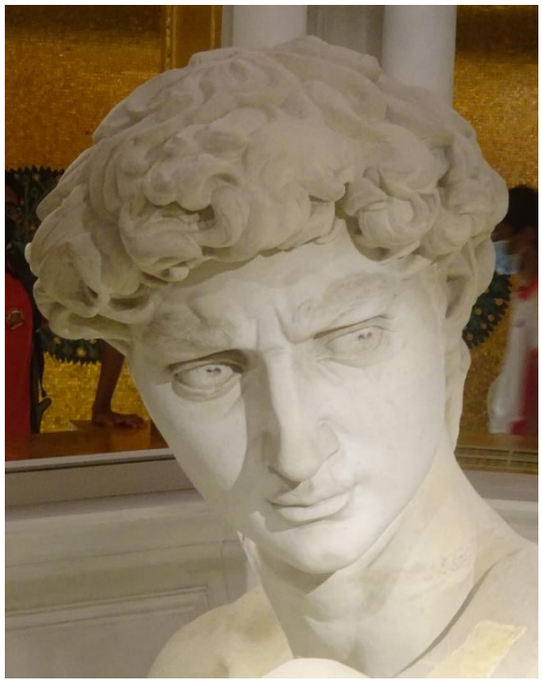

Figure 5: *Michelangelo's David scanned digitally and then reconstituted, in the Italian pavilion at Expo 2020. Note the heart-shaped pupils in the eyes, not easily visible in the original sculpture due to its height.*

Biography
Jonathan Bowen, FBCS FRSA, is an Emeritus Professor at London South Bank University, where he was Professor of Computing from 2000, and Chairman of Museophile Limited (founded in 2002). From 2007 to 2009, he was a Visiting Professor at King's College London. In 2012, he was a Visiting Professor at the Pratt Institute in New York. He has held previous positions at Imperial College London, the Oxford University Computing Laboratory, and the University of Reading. In 1994, he founded the online *Virtual Library museums pages* (VLmp), later supported by the International Council of Museums (ICOM). He has been involved with the EVA London conference since the 1990s. He is also a keen contributor to Wikipedia on cultural and computing subject areas. His books include *The Turing Guide* (Copeland et al. 2017) and *Museums and Digital Culture* (Giannini & Bowen 2019). He is a Life Fellow of the BCS and the Royal Society of Arts.

Chris Michaels

National Gallery / King's College London, UK

National Gallery X – Creative R&D in a time of change

This presentation describes the story so far of National Gallery X (NGX). NGX is an innovation lab launched in 2019 by The National Gallery and King's College London (NGX 2019). Its purpose is to experiment at the boundaries between art, media, research, and technology inside a discipline now being widely understood as Creative R&D. Over the period since its launch, NGX has experimented in areas as diverse as climate change and the representation of gender, brain-computer interfaces, artificial intelligence, and immersive exhibitions (see an example NGX commission in Figure 6).

However, NGX's story is also one shaped by the pandemic and our understanding – and misunderstandings – of what the future (and present) might really look like. This presentation grounds NGX and the wider growth of Creative R&D in a broader view of technology and social innovation, revealing what it really means to innovate inside public institutions.

Biography
Chris Michaels is Director of Digital, Communications and Technology at The National Gallery. He is a Senior Visiting Research Fellow at King's College London and a Creative Industries Fellow at the UK Arts and Humanities Research Council (AHRC). He is a Bloomberg Technology Fellow and was named by Ericsson as a 5G Trailblazer. He acts as an advisor to global cultural and government organisations. He has a PhD from the University of Bristol and an MPA (Master of Public Administration) from University College London.

Figure 6: *Please Enter by Dennis Osadebe, from "The Rules Do Not Apply", an NGX commission.*

Carl Hayden Smith

Ravensbourne University London, UK

Exploring the Ethical Challenges of the Open Metaverse

This presentation explores the ethical challenges of the emerging open metaverse based on two projects:

i) 'Volumetric as a Service' – with the proliferation and democratisation of volumetric capturing facilities and devices what happens to identity as we move from 2D photography to 3D point clouds?

ii) XPRIZE Rapid Reskilling 'Neuro-Adaptive Mixed Reality Training platform' (REAP technologies) – how to develop immersive XR application areas with the help of AI, Machine Learning and Sensory Augmentation.

A significant aspect of the metaverse is that it is a merging of your representation in the real world with a digital representation of yourself in the digital world. Digital twins make up the fabric of the metaverse, where the virtual and the digital are connected through a network of sensors. Already certain mobile phones with their inbuilt lidar technology can create a 3D point cloud of any environment that you are in. This has a direct impact on our privacy. When Google Glass was released, it was immediately banned in department stores as it was deemed an unacceptable invasion of privacy. Now however, depth sensors are being built into all sorts of devices and ethical mechanisms for protecting one's body image and possessions have not been well established. Welcome to the digital twinning of your personal

context. By wearing an AR headset such as the Microsoft Hololens, you by default are generating 3D models of everything you see, this includes other people. The issue is that once your body image has been captured, it can be used, ad-infinitum in deep-fake productions (see Figure 7 and an example Masters and Robots commission in Figure 8).

Once Apple releases its AR headset, the impact on our behaviour will be as dramatic as when the original iPhone was released. Ethical issues will erupt because, through the simple act of looking, we will be making new realities with our eyes.

Volumetric capture studios are springing up all over the world. In light of the Covid pandemic, virtual production techniques have exploded, and the construction of the matrix is firmly underway. Frameworks for how the products of these studios should be used have yet to be formulated. The Non-Fungible Token (NFT) could be used as one way to protect your body image Intellectual Property (IP). This means you would be the rightful owner of your digital self. In this presentation we reflect on how the physical world will itself become an interface, making reality even more machine-readable, clickable, and searchable.

Biography

Carl H. Smith is Interim Head of Research, Director of the Learning Technology Research Centre (LTRC) and Principal Research Fellow at the Institute for Creativity & Technology, Ravensbourne University London. Carl has 20 years' experience conducting R+D in the application of hybrid technologies for perceptual, cognitive and creative transformation. He is focused on using both technological and biological means to alter, probe and study the spectral nature of consciousness. His research focuses on generating new forms of media including Neuroadaptive Mixed Reality Training, Natural Media and Wearable experience (WE). Raising over £10 million in research funding, Carl has worked on numerous largescale Leonardo LifeLong Learning, Erasmus+, FP7, XPRIZE and Horizon European projects including Wearable Experience (WEKIT), REAP, AR4EU (Code Reality), Hobs Academy (LLDC), Hyperhumanism, Contextology (Context Engineering) and Holotechnica.Academy. Carl has given over 300 invited public lectures, conference presentations and keynotes in 40 countries and published more than 100 academic papers. His research interests include Embodied Cognition, Spatial Literacy, Umwelt Hacking, Sensory Augmentation, Artificial Senses and Body Hacking.

Figure 7: *Masters and Robots: 'The Metaverse: A New World of Extended Reality' (Smith & Templar Lewis 2019).*

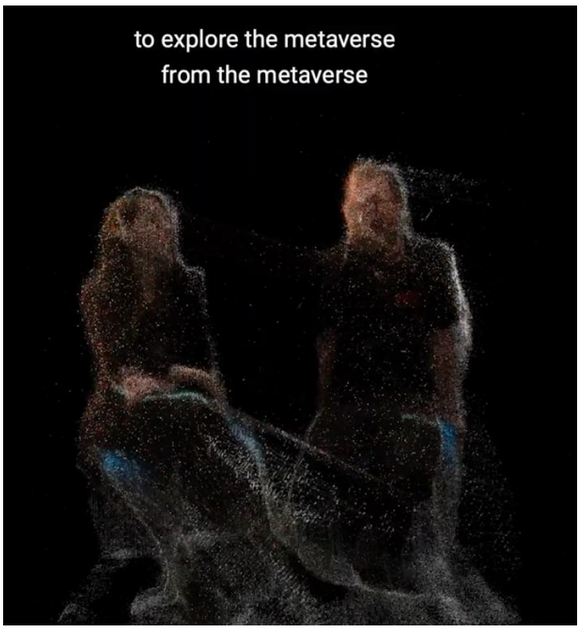

Figure 8: *Dissecting the Metaverse from within the Metaverse.*

4. CONCLUSION

Abandoned Avatar **(Figure 9) by Tula Giannini**

My avatar
abandoned
Landed
too far from reality
Just an avatar
floating in cyberspace
Can't retrace
the place
called home
Lost my virtual phone
Don't see a pub or bar
Cyber death not too far
A surreal experience
No artificial intelligence
No relevance
System down

Figure 9: *Tula's avatar – I've been cartoonized! SocialBook. https://socialbook.io*

This paper records an overview of the speakers' statements with respect to digital art and identity, especially in the context of AI and in the light of the developing metaverse. The issues have been developed by the EVA London 2022 Symposium contributors from varied viewpoints. The paper acts as a starting point for the presentations during Symposium, aimed at promoting further discussion.

What kind of metaverse will be created? Surely, there will be more than one metaverse, and hopefully, there will be a metaverse created by and for digital art and artists. Although computing and technology are driving the computational framework of the metaverse, its design and aesthetic will require digital artists and designers capable of rendering a creative and innovative vision of virtual worlds.

Online information concerning the EVA London 2022 Symposium is available under:

http://www.eva-london.org/eva-london-2022/symposium/

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Synthesis of Abstract Dynamic Quasiperiodic 3D Forms using SIRENs

Andy Lomas
Goldsmiths, University of London
London SE14 6NW, UK
a.lomas@gold.ac.uk

This paper explores using SIRENs, neural networks with periodic activation functions, as a means for synthesising abstract three-dimensional dynamic forms. A SIREN is used to generate a field function for an implicit surface, with inputs for 3D position and time. A wide range of complex quasiperiodic forms can be created, with synthesis and rendering being achievable at interactive rates using modern graphics hardware.

Synthesis of 3D structures. Implicit neural representations. Digital art. Generative art.

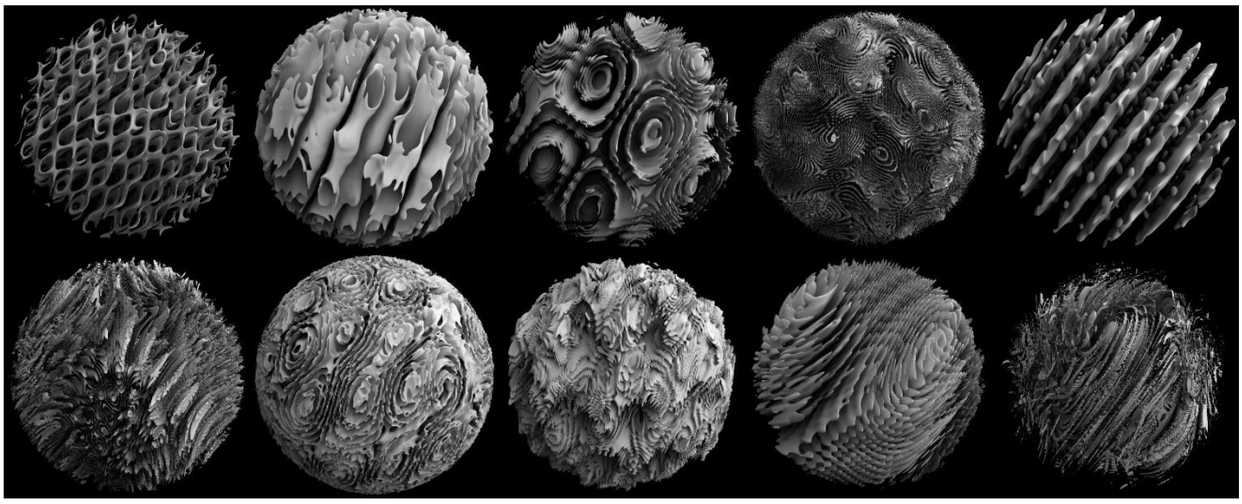

Figure 1: *Examples of 3D forms generated using SIREN networks*

1. INTRODUCTION

SIRENs, neural networks with periodic activation functions, were introduced by (Sitzmann et al. 2020). These networks are shown to have a number of useful properties compared with traditional neural networks that use activation functions such as sigmoid or rectified linear unit functions. In particular they are shown to be good at representing signals, such as audio or image data, including resolution of fine detail. One particularly useful property of SIRENs is that the derivative of a SIREN network is also a SIREN, which can be used to help solve systems with boundary conditions specified by partial differential equations. Sitzmann et al. also demonstrate the use of SIRENs to generate three-dimensional structures by calculating signed distance functions (Osher & Fedkiw 2003) from point cloud data, such as can be acquired from 3D scanning devices.

It is worth noting that there are similarities between SIRENS and synthesis of audio using phase modulation (Chowning 1973, Phase Modulation 2022). In phase modulation synthesis the output of one oscillator is fed into the input of another to

cause periodic phase offsets. One of the strengths of this form of synthesis is that a wide range of waveforms can be achieved with a relatively small number of operators. For instance: the Yamaha DX7, one of the most popular synthesisers from the 1980s, utilises only 6 periodic operators to create all the sounds that it generates. The similarity between SIRENs and phase modulation synthesis has been noted by (Janson 2021) and used to create a neural net based audio synthesiser.

Since SIRENs can be used to generate 3D structures as well as audio signals, this raises the idea of using SIRENs as a basis for synthesising novel three-dimensional forms rather than just to represent existing signals. Similar to the way that phase modulation synthesis can create a rich range of sounds with a small number of operators, a SIREN with a relatively small number of neurons may be capable of generating a wide range of different three-dimensional structures.

A common feature of music and certain types of art are motifs that recur but each time with variations. These appear to be forms that we respond to particularly strongly on an aesthetic level: signals that aren't completely regular but have patterns and structure that change over time and space. If the weights in a SIREN aren't simple rational multiples of each other, they have the potential to generate signals with these types of quasiperiodic patterns.

2. METHOD

To create time-varying 3D forms, a SIREN was implemented with the following structure:

- An input layer with 4 inputs: XYZ position and time.
- A number of fully connected hidden layers, each with the same number of neurons and using sinusoidal activation functions.
- An output layer with a linear activation function and a single output value.

The output value from the SIREN was used as a field function for an implicit surface, with the iso-surface at zero being used to create the 3D form.

The generation of the SIREN was parameterised using a number of hyper-parameters:

- Number of hidden layers (2 to 6).
- Hidden layer size (4 to 20).
- Hidden layer weight multiplier (1 to 100).
- Final layer weight multiplier (0.1 to 10).
- World scale multiplier (0.1 to 10).
- Time multiplier (0.1 to 1).
- Power series ratio (0.5 to 1).

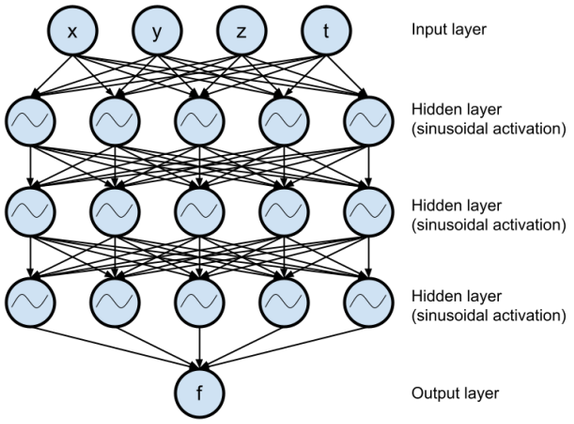

Figure 2: *Typical structure of SIREN used to generate 3D forms*

The weight and bias values for each neuron were generated using random values with ranges specified by the layer weight modifier values.

The Power Series Ratio parameter was used to specify a multiplication factor to be applied to the input weights of each successive neuron in each of the hidden layers. The intention was to ensure that the neurons in each layer would have a distribution of input weight values that would promote a range of frequency responses in the output.

In (Sitzmann et al. 2020) when generating 3D surfaces they impose a constraint using a partial differential equation to ensure that the field function generated by the SIREN is a signed distance function. This introduces an additional step where the weights in the SIREN are fitted to the boundary conditions using gradient descent. For this work a signed distance function wasn't considered necessary since all that was required was an iso-surface at zero which was rendered using marching cubes to create a triangle mesh. Relaxing this constraint allowed the SIRENs to be generated without fitting weights, allowing significantly faster generation of the SIREN from the hyper-parameters.

To make use of massively parallel processing, such as is available with modern graphics hardware, the SIREN network was implemented in CUDA. The extraction of the iso-surface from the SIREN was also implemented in CUDA, with the output of the SIREN evaluated over a regularly spaced 3D grid of voxels and using marching cubes (Lorensen 1987) to generate a triangle mesh. This data was then used in NVIDIA's OptiX ray-tracing library for rendering (Parker et al. 2010).

Additional final layer outputs could be optionally added to the SIREN to generate an RGB colour for each position in 3D space. This was used as a procedural 3D texture to change the diffuse colour

of the iso-surface during rendering. By being generated using the same network, the intention was that these colours would coherently change with the shape of the surface.

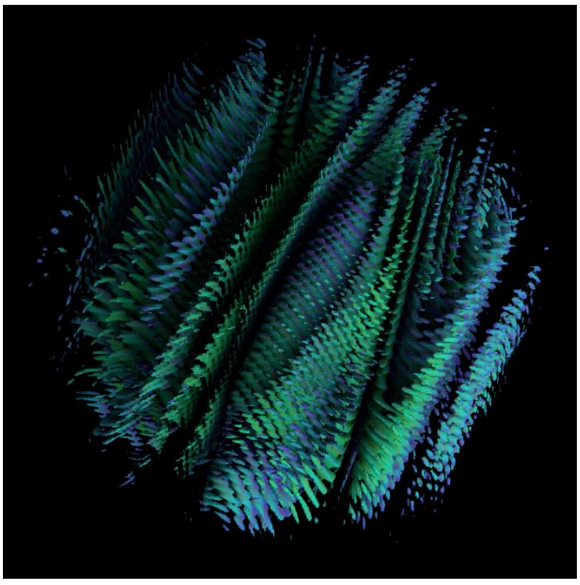

Figure 3: *SIREN form with RGB colour*

Additional hyper-parameters could be included to add an offset to the field function based on the radial distance from the world centre. This allowed forms to be created that have a limited bounding volume, since beyond a certain radius the field functions will either be strictly positive or strictly negative.

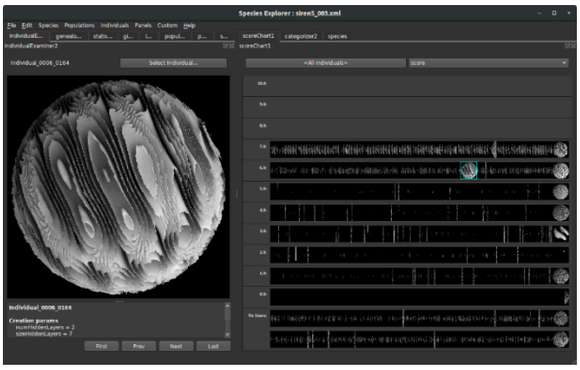

Figure 4: *Selecting SIREN hyper-parameters using Species Explorer*

To explore the range of possible outputs, the author used his Species Explorer software (Lomas 2016) to vary the hyper-parameters and sample results. The output was automatically classed as being a failure and allocated a score of zero if no triangles were generated when extracting the iso surface. All other cases were given a score value by the author on a scale from 1-10, which was used as a fitness value to generate new individuals using interactive genetic algorithms and machine learning methods implemented in Species Explorer.

To evaluate the dynamic behaviour of the forms over time, extensions were added to Species Explorer to allow the viewing of animated .gif files for each form, as well as to launch a live simulation running the SIRENs in an interactive viewer.

3. RESULTS

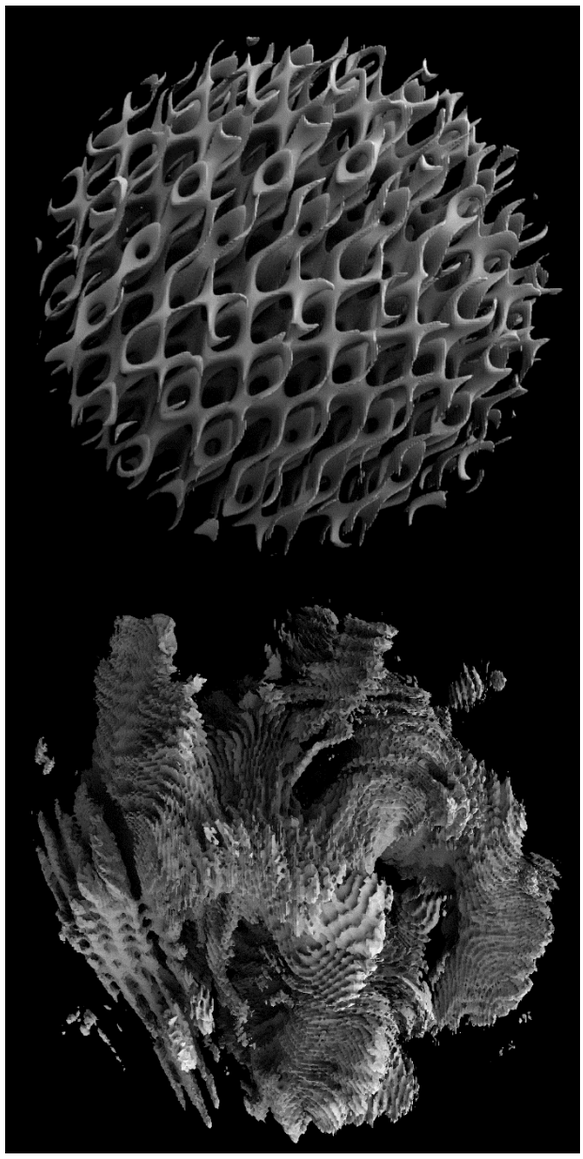

Figure 5: *Generated forms showing varying amounts of regularity*

The described system created a wide range of generated forms: from structures that appeared to have significant amounts of regularity through to forms that appeared to be far more noisy, irregular structures. In between these extremes the system

generated many forms with repeating motifs but where each repetition shows different patterns.

The computation of the forms (evaluating the SIREN in a voxel grid, generating triangles using marching cubes and rendering using OptiX) is sufficiently fast to allow animated structures to be generated in real-time if the resolution of the voxel grid is sufficiently small. A voxel grid with 128 cubes on each side (2,097,152 sample points) would generally allow updates at 30fps or faster using an RTX 2080 Ti GPU and rendering at 1024x1024 pixels. For higher quality renders, voxel grids of up to 512 cubes on each side (134,217,728 sample points) could be calculated while staying within the GPU's memory limitations with render times of around 1 second per frame.

The output of the system was tested in a variety of contexts including:

- A simple OpenGL viewer that allows the user to interactively move the form in 3D space using a virtual trackball interface while it updates dynamically.
- Anaglyph stereoscopic rendering to view the results in 3D.
- Stereoscopic viewing in a VR environment using Unreal Engine and an HTC Vive head mounted display.
- Rendering for presentation in a Fulldome environment, including with anaglyph stereoscopic 3D.

The use of field functions facilitates creating transitions between different forms by simply interpolating between the field functions before extracting the iso-surface. This works even if the surfaces generated by two SIRENs have different topologies. A video showing a series of such transitions can be seen at (Lomas 2022a), together with an anaglyph stereoscopic 3D version of the same transitions for viewing with red blue/cyan glasses at (Lomas 2022b).

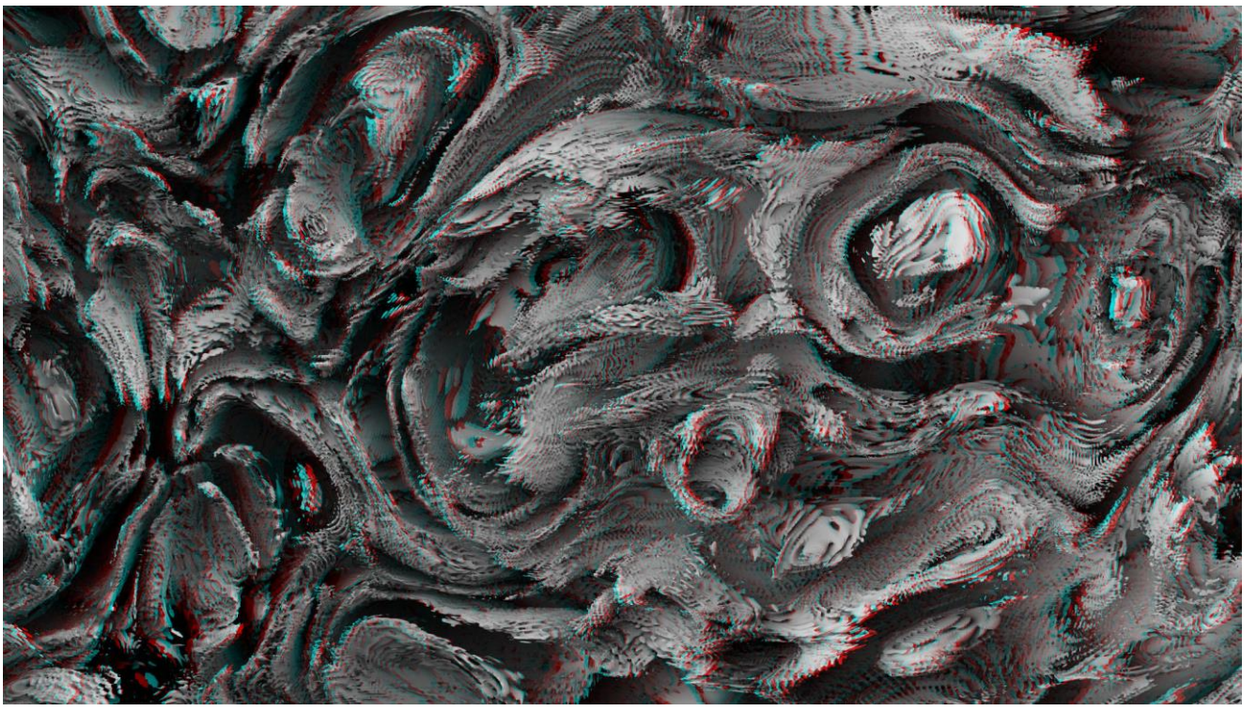

Figure 6: *3D anaglyph rendering of a SIREN form (for viewing with red blue/cyan glasses*

4. DISCUSSSION

The ability to generate forms in real-time allows the potential to interactively manipulate parameters, including some of the hyper-parameters used to generate the SIREN. The author has tested this using a MIDI controller to update parameter values in real-time while viewing the results.

In some of the generated forms there are noticeable sampling artefacts. These are to be expected since the field function is being evaluated at a discrete set of regularly spaced points. Simply increasing the resolution of the voxel grid should improve this quality, but it should be noted that phase modulation techniques often generate high frequency sidebands that could exceed any discrete sampling level.

There are alternative rendering algorithms for iso-surfaces that could yield higher quality results but potentially at the cost of increased rendering time. For this work the author explicitly didn't use the constraint from (Sitzmann et al. 2020) to generate signed distance functions. This was done to make generation of the SIREN networks significantly faster. However, signed distance functions have potentially useful properties, including enabling use of rendering algorithms such as sphere tracing that can generate very high quality anti-aliased results (Hart 1996).

5. CONCLUSION

This study shows that SIRENs with a small number of neurons can be used to synthesise a wide range of different 3D forms with potentially interesting quasiperiodic structures. This can be seen as a technique for synthesising form in a similar manner to phase modulation synthesis of audio, creating rich complex forms from a small number of periodic operators. These are often visually interesting, creating dynamic structures with repeating but varying motifs.

Using current GPU technology, the results can be calculated in real-time, including manipulating hyper-parameters used to generate the SIRENs. This opens possibilities for live interaction, creating 3D forms that respond to user interactions or other input such as live music.

There are a number of directions that future work could take, including:

- Experimenting with different topologies of the SIREN network and different distributions of weights on the neurons.
- Audio synthesis using the same SIREN used to generate 3D forms to create audio directly connected to visual material.
- Implementation of a tool to generate forms using SIRENs for AV displays or for live mixing by VJs.

6. ACKNOLEDGEMENTS

I would like to acknowledge the support of Plymouth University for the use of their Fulldome environment to test the stereoscopic output from the SIRENs.

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Tackle Climate Change Through Art: A case study

Florent Di Bartolo
LISAA, Gustave Eiffel University
Bâtiment Alexandra David-Neel
2 All. du Promontoire
93160 Noisy-le-Grand, France
florent.di-bartolo@univ-eiffel.fr

Xavier Hautbois
CHCSC, University of Versailles
Saint-Quentin-en-Yvelines
47 Boulevard Vauban
78280 Guyancourt, France
xavier.hautbois@uvsq.fr

This paper describes the creative process behind the creation of an audiovisual installation. Titled *The Great Acceleration* (2021), this installation is built upon scientific data simulating the retreat of the Ross Ice Shelf from 2015 to 2100. The dataset is the result of a computer simulation based on a scientific model provided by researchers from the Laboratory for Sciences of Climate and Environment (LSCE). The paper details the methodology used to offer a sensitive experience of climate change through the analysis of a large amount of data and the creation of generative audiovisual compositions. It describes the artistic approach and how the dataset related to the Ross Ice Shelf activity has been processed in order to create visual compositions and shape sounds. The paper also explains the relationship between these images and sounds and how they react to external outputs such as the presence and movement of visitors within an exhibition space.

Datascape. Creative visualisation. Anthropocene. Climate Change. Visual music. Digital art. Music.

1. INTRODUCTION

This paper describes the creative process behind the creation of an audiovisual installation that has obtained the financial support of the Diagonale Paris-Saclay through its call for projects *Expérimentation 2020*. Titled *The Great Acceleration* (2021), this installation is built upon scientific data evoking the uncertain future of Antarctica's melting ice. The selected dataset relates more precisely to the transfiguration of the largest ice shelf in Antarctica: The Ross Ice Shelf from 2015 to 2100. The dataset is the result of a computer simulation based on a scientific model provided by researchers from the LSCE laboratory: a laboratory that studies past present and future climate from the analysis of natural archives and the development of numerical models.

The paper details the methodology used to offer a sensitive experience of climate change through the creation of an interactive installation. This methodology is built upon the analysis of a large amount of data and is used to create generative audiovisual compositions that can be seen at this address: http://vimeo.com/608419914/c27388c024.

First, the artistic approach and the processing of the dataset related to the activity of the Ross Ice Shelf is defined. Then, we explain how images and sounds have been created and animated while using this dataset as raw and refined materials. Finally, we discuss the dynamic relationship between these images and sounds and how they react to external outputs such as the presence and movement of visitors within an exhibition space.

2. ARTISTIC APPROACH AND DATASET

2.1 The musical work

The musical part of the installation is based on a work of mixed music for cello and electroacoustic (9'16) by Xavier Hautbois composed on the theme of melting ice. In accordance with the slowness of the whole installation, the general atmosphere of the musical piece has a static and timeless aspect, despite the moments of tension carried by the instrument which plays the main role: the cello.

The soundtrack that carries the music is produced by virtual instruments. It is in perpetual and slow development. Two recognisable melodic instruments emerge from it: the cello, playing the

dominant role, and the celesta, staying back, which adorns the song of the cello in an almost concertante writing.

A light granular texture accompanies this ensemble in an autonomous way. This texture is built from natural sounds recalling flowing waters as well as ice cracking and breaking up. Although the sound background presents more or less strong tonal reminiscences, the cello melody is expressed in atonal and contemporary expressions.

Formally, the musical piece is made up of eight well-defined sequences. In each one of them, the cello exposes one or more modes of play:

(i) legato and sustained sounds;
(ii) noisy sounds *sul ponticello* (on the bridge);
(iii) pizzicato sounds;
(iv) short sounds *col legno* (with the wooden part of the bow) or percussion on the body of the instrument;
(v) simple artificial harmonics;
(vi) glissandi with harmonics;
(vii) tremolo sounds;
(viii) energetic ostinatos with accents.

These bowing techniques create musical variations which affect the movements of the particle systems used to depict the evolution of the Ross Ice Shelf activity.

2.2 Data selection

The installation *The Great Acceleration* is built upon a dataset provided by researchers from the LSCE working on past and future interactions between climate and ice sheets.

The dataset is an output of the GRISLI ice sheet model: a model able to reproduce expected grounding line advances during glacial periods and subsequent retreats during terminations with reasonable glacial–interglacial ice volume changes (Quiquet et al. 2018). The dataset represents with the help of a Cartesian coordinate system the possible retreat of the Ross Ice Shelf from 2015 to 2100.

The first step to develop an installation based on this data and the movements it contains was to give it a default representation by creating a program able to display the evolution of the Ross Ice Shelf activity. These first attempts of visualisation were used to verify that the data has been handled properly by being able to retrieve an accurate representation of the Ross Ice Shelf that could be compared to visualisations used by climate scientists.

These first images of the Ross Ice Shelf activity were also used to identify a specific parameter, an iconic variable that is used as the main material to create images and sound related to the **Great Acceleration**: a concept that depicts the dramatic acceleration in human enterprise and its impacts on the Earth system over the last two centuries (Steffen et al. 2015).

Amongst the many parameters available, **ice surface velocity** has been selected due to its significant increase over the observed period of time. The increased velocity of glaciers and ice sheets due to climate change is one of the main causes of sea level rise. Ice velocity represents one of the most important parameters researchers used to study ice sheet and glacier dynamics. Rates of ice movement vary from one glacier to another and change with depth. For example, glacial motion gets smaller on small glaciers or in the centre of ice sheets.

In this case only the ice sheet surface velocity has been taken into account. The internal and sliding velocities of the Ross Ice Shelf have not been selected to shape the audiovisual compositions presented in this paper.

2.3 Data translation

The data selection process was followed by its treatment. Ice velocities were used to define the outlines of a constantly evolving territory. Ice surface velocities were originally related to a specific position on a Cartesian grid. Together, they draw the movements animating a territory of 16 km by 16 km which represents the Ross Ice Shelf. As such, they have been first used to create grayscale images of ice velocities at the ice shelf surface. Then, these digital images have been processed using blob detection methods in order to identify different regions inside each of them (Figure 1). This computational process serves a speculative inquiry as any process of **speculative computing** (Drucker & Nowviskie 2004). It aims to produce a useful aesthetic provocation that is the result of a subjective interpretation enacted by an interpreter and predicting the disappearance of the Ross Ice Shelf.

The regions identified show 5 different levels of intensity related to the ice shelf movement. They allow us to follow the evolution of the Ross Barrier and to observe the acceleration of Antarctic Ice Sheet mass loss over a long period of time. These regions are mainly defined by their curves, surface, position and the level of intensity they are associated with. Their curves represent the main element used to create the **datascape** of the installation *The Great Acceleration*.

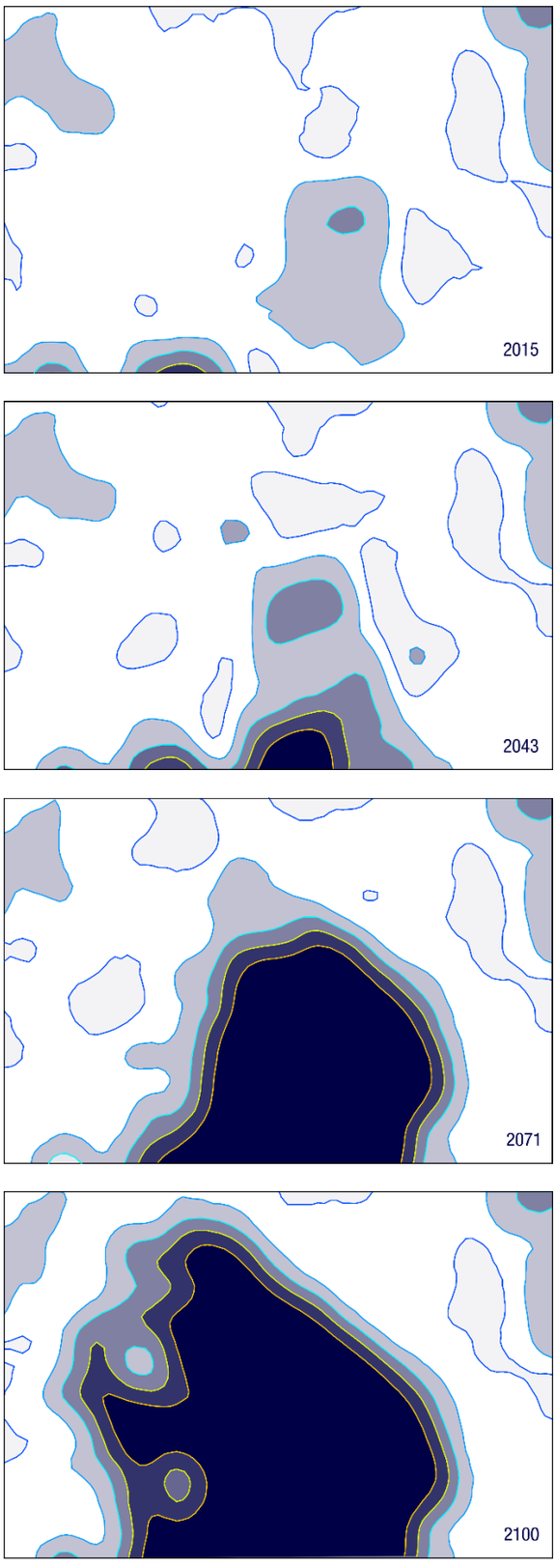

Figure 1: *Examples of different regions identified using blob detection methods. The curves' colour code ranges from blue (low velocity) to red (high velocity).*

3. THE CREATION OF GENERATIVE AUDIOVISUAL COMPOSITIONS

The lists of 2D vectors that define each region are at the core of the images that depict the activity of the Ross Ice Shelf. These images are built using multiple particle systems that redraw the curves of each region over time in a 3D environment (Figure 3). The third dimension of the 3D space is used to separate the regions between them based on the intensity of the movements they are representing.

With the colour code used to draw these lines, this spatial distancing recreates figurative representations of the Ross Ice Shelf that allows their viewers to observe the retreat of the ice barrier.

The curves of each region are used to modulate the sound composition using IanniX: a graphical open-source sequencer. They become **velocity curves** modifying in real-time musical parameters. Each curve is assigned to a specific sound source depending on its velocity level. Celesta is assigned to curve level 1, the harmonic background to levels 2 and 3, while the granular texture is assigned to levels 4 and 5. The perimeter of each curve influences the loudness of the sound assigned to it. Therefore, the granular texture becomes more present as the curves of levels 4 and 5 appear and grow stronger over time. The sound generator which controls this progression sets noticeable variations in the balance between voices.

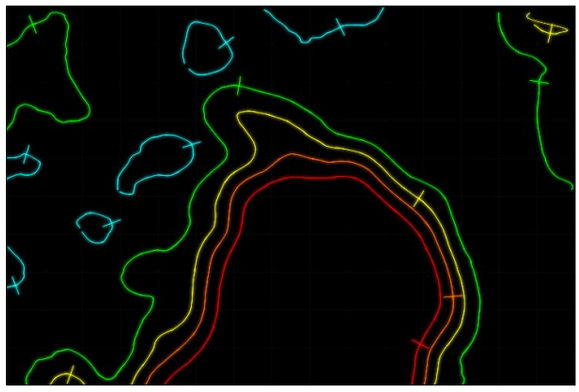

Figure 2: *Velocity curves in the graphic space of the IanniX sequencer.*

In the sequencer IanniX, a playhead slides on every velocity curve (Figure 2). Every curve is being played in a loop at a constant speed. The shape of these curves acts on band-pass filters in order to give an iridescent and changing colour to the sounds they are associated with. Depending on the angle of rotation of their playhead, the sound quality takes on darker or, on the contrary, brighter tones. Each velocity curve has its own length and

shape. This characteristic permits the creation of complex filter overlays over time.

The whole installation tends to point out ecological issues through the lenses of an objective observer. The retreat of the Ross Ice Shelf is presented as a slow process without much emphasis on ice calving or the rise of sea level. The installation tends to show the melting of ice shelves as the result of an unstoppable force difficult to see to the naked eye. The installation builds a representation of this long process by giving it a figure that slowly emerges through time over a period of approximately 10 minutes covering 85 simulated years (Figure 3).

4. AUDIO-REACTIVE PARTICLE SYSTEMS

One of the key elements of the installation *The Great Acceleration* was to create a close relationship between a visual and a musical expression using custom written programs. The goal was to design a generative system able to simultaneously create images and sounds from the same refined data. In this case, “sounds” represent modulated versions of audio samples combined together inside a sound composition made of height musical sequences and linked to audio track settings. On the other hand, “images” represent animated visual compositions built mainly using particle systems. Images and sounds are shaped by the same ice velocity data. They also interact in many ways.

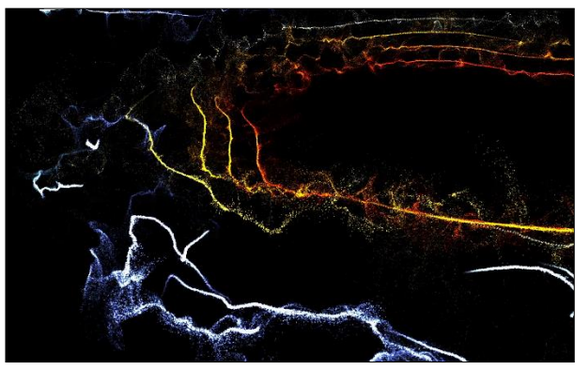

Figure 3: *Example of the datascape made of different curves drawn using particle systems.*

Each mode of playing of the cello has a singular influence on the particle systems used to express the Ross Ice Shelf activity. This interaction between images and sounds is built upon a communication between two entities: a sound generator and an image generator exchanging information. The sound generator provides in real-time information about the number of the musical sequence being played, the amplitude of the sounds as well as the current mode of playing.

These last two pieces of information are used together to modify the strength of forces applied to particle systems in order to recreate well-defined movements inside a visual composition related not only to a specific mode of playing but also to sound intensity. The visual compositions respond to the sound composition by taking into account the transition from one mode of playing to another and the strength with which they are introduced and then played. The movements of the visual compositions tend to follow the rhythm being suggested by the current audio playing mode.

Short sounds introduce, depending on their intensity and related playing mode, almost invisible Brownian noise inside a visual composition or, on the contrary, sudden movements able to vigorously displace entire particle systems. Another example: the legato sounds of the cello related to the first playing mode create slow theatrical movements inside a visual composition that affect almost every particle by forcing them to follow a path specified by a force field. These new trajectories are defined by taking into account the actual position of each particle. They have the effect of momentarily blurring the lines used to represent the Ross Barrier.

5. DESTRUCTED FORM AND ARITHMETIC CONSTRAINTS

5.1 Destructured musical form

The musical form is “destructured” (Bootz & Hautbois 2020). Its processing is not the destruction of a preconceived form or its negation, but an extension of a formal, harmonic or acoustic work. A destructured musical form reveals sonic details which did not appear in the original work and which are changing its characteristics, much like a magnifying glass focusing on fragments of a drawing under observation.

The musical score is controlled by the sound generator which gives life to musical aspects of the work not present in its original and closed form: details underlined by the reorganisation of the musical form, by the application of filters activated in real-time or by the balance between voices.

In this case, the music explores new sound configurations of the initial work in order to replay endlessly, but always in a different way, through interactivity, the inexorable process of ice shelves retreating.

The destructuring of the musical form is orchestrated by performing different actions:

(i) The differentiated treatment of the four sound sources extracted from the initial piece.
(ii) The application of filters and spatialisation effects based on the reading of velocity curves.
(iii) The interaction of the public with the installation.
(iv) The reorganisation of the musical form itself according to arithmetical constraints.

5.2 Arithmetic constraints

The original musical composition lasts 9 minutes and 16 seconds. As a multimedia installation theoretically has no end, the musical form had to be rethought in order to take into account repetitions of sequences, while avoiding this repetition being too frequent. As part of the installation, the musical composition is reorganised each time the cycle of eight sequences comes to an end.

These new forms of arrangement are not randomly chosen. They follow arithmetic constraints that allow 15 different combinations while maintaining a sense of musical order.

Table 1: *Repetitions of musical sequences*

1	2	3	4	5	6	7	8
5	2	3	4	1	6	7	8
1	2	3	8	5	6	7	4
5	2	3	8	1	6	7	4
1	2	7	4	5	6	3	8
5	2	7	4	1	6	3	8
1	2	7	8	5	6	3	4
5	2	7	8	1	6	3	4
1	6	7	4	5	2	3	8
5	6	7	4	1	2	3	8
1	6	7	8	5	2	3	4
5	6	7	8	1	2	3	4
1	6	3	4	5	2	7	8
5	6	3	4	1	2	7	8
1	6	3	8	5	2	7	4

Considering the musical sequences numbered from 1 to 8, the following rule has been applied: each sequence *n* can only be followed by the following sequence *n*+1 in the initial series (which constitutes the order of succession of the musical work) or else by the sequence located five steps forwards in the series *n*+5 (Table 1).

These new forms of arrangement between audio sequences don't affect the way the visual compositions are organised: The visual compositions follow a fixed timeline. They start by drawing a landscape that depicts the Ross Ice Shelf in 2015 and slowly evolve through the years until reaching 2100 that marks the end of the simulation period.

Nevertheless, each new cycle is not identical to the previous one. Each cycle of musical sequences being different from the previous one, the visual sequences, which react to the music, evolve each time in a different way, while being generated from the same velocity data linked to a specific year.

The arithmetic constraints applied to reorder the audio sequences at the end of each cycle permit to always end a cycle with the audio sequences 4 or 8. This example shows how the rules that associate musical sequences with visual ones are defining a non-unilinear structure which allows building audiovisual momentum and not random chaos.

6. INTERACTIONS AND INTERACTIVITY

6.1 Interactions between visual compositions

Interactions and interactivity play an important role in the arrangement of visual compositions and evolution of the musical form. The main visual compositions are generated in real-time from velocity data related to a specific year and respond to different modes of playing. They represent individual images of the datascape drawn to show the evolution of the Ross Barrier using particle systems (Figure 3).

This datascape is presented through the eyes of two different cameras. The first camera is used to display a panoramic view of the curves and revolves slowly around them. It works in tandem with a second virtual camera which is used to target specific curves of the datascape from another point of view. This camera is closer to the curves and moves towards them. It provides fragmentary and animated views from above. The visual sequences created using these two different cameras last between 10 and 15 seconds. They can be presented one after the other but can also be automatically swapped with three other types of visual sequences in relation to the musical sequence being played and its attributes. These three other types of visual sequences represent:

(i) Icebergs that have broken off an ice shelf.

(ii) Meltwater.
(iii) Filtered views of the dataspace.

Figure 4: *Representation of icebergs that have broken off an ice shelf.*

They are built on knowledge acquired while working on audio-reactive point clouds (Di Bartolo 2019). The transition from one visual sequence to another is related to sound events. For example, when the cello ceases to be audible, another type of visual composition can appear. This composition represents icebergs moving slowly towards the camera (Figure 4). While this representation is still made of particles, it offers a counterpoint to the visual compositions displaying the datascape. Its stability contrasts with the slow and long movements generally applied to the datascape according to a specific musical playing mode.

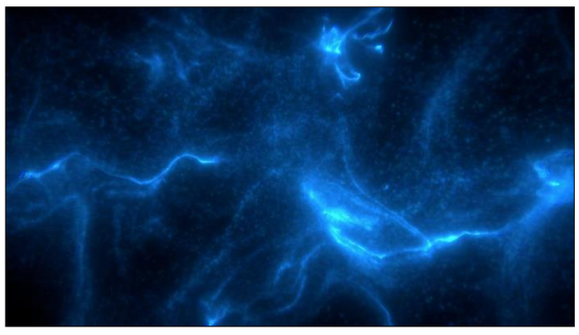

Figure 5: *Representation of meltwater.*

The third type of visual compositions gives birth to abstract forms. It has been created to generate meltwater representation from the inside of an ice shelf (Figure 5). The virtual camera used to capture this scene is inside the particle system used to define the visual composition. A turbulence field constrains the particle movements in order to give shape to meltwater slowly going through sheets of ice.

While these last two types of visual compositions are not directly created from ice surface velocity data (unlike the datascape) they evolve with it. The size of icebergs decreases over time while the movement of meltwater is accelerating throughout the entire simulation period. The shrinking size of icebergs shows they are doomed to fade. Icebergs act as contemporary vanitas. They remind us of the transience of life (Remaud 2020).

6.2 Experiencing interactivity

The fourth and last type of visual compositions is only being displayed in interaction with the viewers. Several motion detectors are used to monitor the movements of the public inside the exhibition space. The data outputted by the different sensors is processed to assign their current location to four different zones of equal area. It allows the viewers to interact with the datascape based on its location.

Figure 6: *Example of a filtered view of the datascape displaying a single curve.*

When the presence of a visitor is being detected, in one of the four zones, for the first time of a simulation year, the fourth type of visual composition is used to filter the datascape by slowly redrawing its largest region while masking every other visual element (Figure 6). This interactive behaviour creates a mapping between the simulation space and the exhibition space. The location of each sound in the quadraphonic space (defined by the installation speakers) is established according to the position of the velocity curves and the position of their respective playhead in the sequencer IanniX. The public is therefore surrounded by sounds, each having its own trajectory in space.

This fourth type of animated visual composition is, as the datascape, responsive to the musical composition and its different mode of playing. It

also shows a progression throughout the simulated period using progressive colour changes.

The audio composition responds to the appearance of this fourth type of visual. The display of a single region is used to mute all the sounds which are not related to the selected region in the sound generator. This filtering process allows the viewers to listen closely to a single velocity curve. It produces a zoom effect by focusing on a musical detail of the electroacoustic piece which participates in the controlled and indeterminate destructuring of the audio work.

7. ACKNOWLEDGEMENTS

We would like to thank the researchers of the LSCE laboratory (Laboratory for Sciences of Climate and Environment) and in particular Sylvie Charbit for providing the dataset related to the Ross Ice Shelf activity. Our thanks also go to Aurélien Quiquet and Christophe Dumas who ran the simulations at the origin of the dataset.

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Opening Black Boxes: 3D-CT digitalisation of historical cipher machines

Matthias Göggerle
Deutsches Museum
Munich, Germany
m.goeggerle@deutsches-museum.de

1. INTRODUCTION

Within the framework of the three-year project "3D-Cipher" – funded by the German Federal Ministry of Education and Research – the Deutsches Museum is conducting computed tomographic scans of 60 historical cipher machines of its collection. The museum is thereby extending its experience with CT scans as part of the large-scale digitisation measures established in the previous years. First projects utilising computed tomographic scans have been carried out in the past, like the large-scale scan of the WWII aircraft Messerschmitt Me 163 (www.iis.fraunhofer.de/en/profil/jb/2019/xxl-ct-me-163.html). The non-destructive look inside historical objects is the primary advantage for the use of the CT technology in the Deutsches Museum. Many exhibits cannot be opened physically for conservational concerns, e.g. many of the crypto devices. The CT technology thus gives us insights into historical objects, which would not be possible otherwise without destroying the fragile devices.

2. TECHNOLOGY

The CT technology uses X-ray measurements from various angles for the capturing. While technologically similar to medical CT scanners, industrial CT scanners move the object instead of the scanner itself and the X-ray beam uses higher electromagnetic radiation, which is necessary to penetrate dense materials like metal.

The resolution of industrial CT scanners depends on the size of the facility and the scanned object. Nano-CT scanners reach resolutions up to 0.5 µm, while the Macro and XXL scanners of the Fraunhofer EZTR (https://www.iis.fraunhofer.de/en/ff/zfp.html) used in the 3D-Cipher project can create resolutions up to 0.15 mm.

Different materials absorb the x-ray beams to different degrees. As a consequence, denser materials appear lighter in the final images than materials with lower density. This is usually represented in a grey scale histogram. The result of the scanning process are thousands of individual x-ray images from which one can reconstruct a digital 3D-CT model.

3. BENEFITS AND EXPLOITATION

The CT technology adds value in different ways to the museum work. The before mentioned non-destructive view inside historical exhibits generates new knowledge about the specific object history. The operating mode of cipher devices from the 1970s onward is barely known and they cannot be opened without potentially destroying parts of the mechanism. Even for well-researched machines like the Enigma, the CT scans can add value with the possibility to measure in the submillimetre range. The results can be used to improve and build functional replicas.

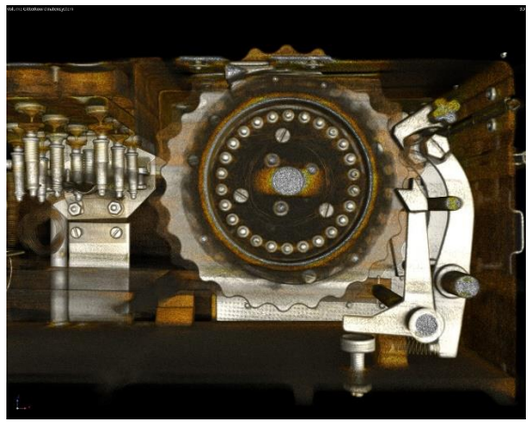

Figure 1: *Rotor of an Enigma M4, colourized 3D-CT model.*

The technology can also answer conservational questions with different material analysis tools. Via

structural mechanical analysis, it is possible to identify damaged or destroyed parts or material degradation, e.g. the strong corrosion of the outer and inner parts of our cipher device SG 41 is visible in the CT images.

Apart from research questions, 3D-CT data can complement museum exhibitions and help explain complex issues. Since we can identify, extract and animate individual parts, the CT technology contains a lot of potential for museum communication.

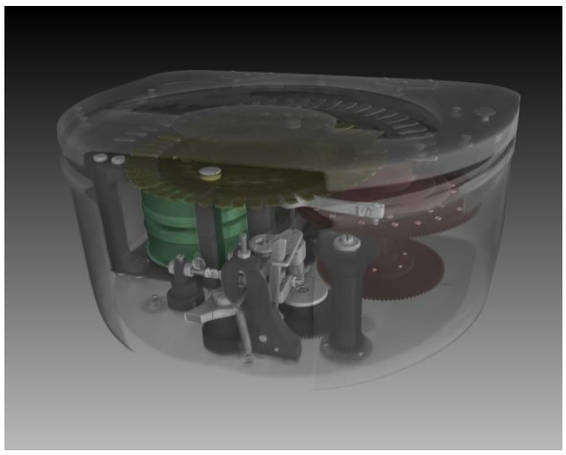

Figure 2: *Segmented and colourized parts of the cipher device Kryha Standard, 3D-CT model.*

4. CHALLENGES

Nevertheless, it is also important to mention the limitations and challenges of the computed tomography technology. The biggest issue with large scale CT scans is their high costs, easily ranging in the tens of thousands of euros. Consequently, large-scale CT digitisation is almost impossible to achieve for publicly funded museums. Additionally, the analysis and visualisation software by the market leaders is very expensive. There are however very powerful open source alternatives like 3D slicer (https://www.slicer.org/).

It also takes time to learn how to read the data and pictures, e.g. to distinguish between digital artefacts and deviations in the real object. This is especially true for largely mono-material objects. A surface determination, often required for further analysis, is much more accurate if it can be based on clearly distinguishable grey scales. The segmentation of different parts, like the mechanism of a machine, is therefore a difficult and time-consuming task.

Furthermore, the created CT data is very large. Depending on object size and resolution, the files reach up to 50 GB or even 500 GB. This requires expensive hardware and variable downsizing for online viewers. Two promising web viewers are the RecoWeb viewer of the Fraunhofer EZRT (https://recoweb.gnm.de/extern/Musikinstrumente) and the open source viewer MorphoSource (https://www.morphosource.org).

Figure 3: *Colourized 3D-CT model of the "Schlüsselgerät SG 41", intended to be the successor of the famous Enigma in WWII.*

Other challenges are the long-term data storages and the required servers to host the data. The Deutsches Museum is involved in different (research) data infrastructure projects and initiatives to challenge these issues for all kind of research data (https://4memory.de/; https://www.kultsam.de).

The self-imposed expectations of the 3D-Cipher project align with the abovementioned benefits and challenges, to prepare and supply open source data for research and to use this data to display them to the public and the museum visitors. In addition, we reflect the working process, the challenges for researchers and the possibilities of creating a sustainable digital infrastructure.

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Seen Description: Visualising and crafting data in mixed realities

Rehan Zia
Bournemouth University
Poole, UK
rzia@bournemouth.ac.uk

The immense potential of the convergence of digital technologies such as, 3D scanning and photogrammetry, 3D printing, motion capture, real time performance capture and mapping, camera tracking, interactive lighting and virtual production, is yet to be fully grasped, exploited and appreciated. The creative aspects of this technology convergence offer exciting new opportunities for the visualisation, mixing and crafting of materials from the physical and digital worlds; real world objects can be 3D scanned, manipulated digitally, printed out using the 3D printing process, and painted in the real world to be used as set dressing on a virtual production set to be recorded on digital video. The real and digital states of objects have become fluidly interchangeable offering unprecedented creative control to artists to shape the world at will. This paper highlights some of the possible applications – beyond the mainstream usage in film and games production – that the convergence of these technologies offer based on case studies of select student and staff projects undertaken at The National Centre for Computer Animation at Bournemouth University, UK. These applications include, but are not limited to, creative art, photography, digital heritage and preservation, and customised applications for rehabilitation of patients.

Visualisation. Mixed reality. Virtual Production. Digital heritage and preservation.

1. INTRODUCTION

The National Centre for Computer Animation (NCCA) at Bournemouth University, UK was established in 1989 and has been a pioneering institution in computer animation education. In 2012, the NCCA received the Queen's Anniversary Prize for contribution to world-leading excellence and pioneering development in computer animation. The key to the NCCA's success is its interdisciplinary emphasis across arts, science and technology (Comninos et al. 2010). As such, the definition of "creative" and the "technical" do not conform to arts and science respectively but are seen as interchangeable; programming can be creative and [texture or matte] painting can be technical, for instance. Beyond the creative and technical elements, a number of projects in the NCCA have also blurred the boundaries of the analogue and digital domains, seamlessly transposing and crafting material both the in the real and digital worlds. This paper explores a range of NCCA staff and student projects that have made this material transposition possible.

2. CASE STUDIES

2.1 The Hunt

The Hunt (Olsauskaite et al. 2022) was a computer animated film created by Adele Olsauskaite, Elisabeth Wetchy and Beate Nieuwoudt as part of their Final Major Project at the NCCA. The students wanted to create a painterly look in the surface textures of the environment and characters in keeping with the narrative treatment for the project. They spent a considerable amount of time testing ways of creating painterly looking textures using computer graphics (CG) but were not happy with the results. They finally ended up painting textures using real paint in the real world (see Figure 1), scanning these textures digitally (see Figure 2), and applying them to the 3D objects in the digital world (see Figure 3). The scanned textures could be manipulated before being applied to the objects and the overall look of the final rendered images could also be tweaked further during the lighting, look development, rendering, compositing and colour grading stages.

Olsauskaite (Olsauskaite, Nieuwoudt & Wetchy 2022) states that "From a practical standpoint there

isn't much use in going through such process, but as an experiment it was quite fun. [It] Also shows that there is space for multiple medias interacting together in unexpected ways. I know for me, never really having used digital tools for painting before my BA but having painted with oils and acrylics from an early age, there was a steep learning curve and a certain rejection to it, and while at the time of the project I wasn't soooo bad with digital painting, searching for ways to incorporate more familiar real world tools was comforting. That being said, I'm not sure how much of that process translated into the film after all of the filters were applied.".

Figure 1: *Painted textures on canvases by Olsauskaite*

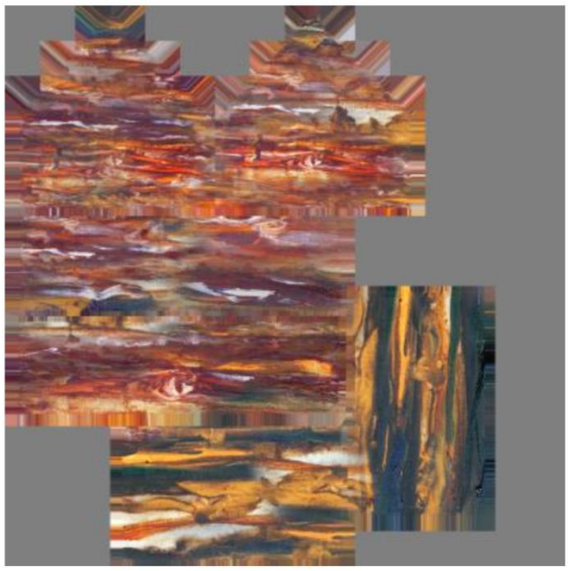

Figure 2: *Unwrapped texture map created from the scanned paintings*

Nieuwoudt (Olsauskaite, Nieuwoudt & Wetchy 2022) adds: "I really enjoyed exploring textures in traditional media with Adele and found it helped set a headspace while we were trying to find ways of applying and conveying them in 3D. I know keeping the shapes readable was one of the biggest problems we faced and I'm certain it was the right decision to limit the number of moving camera shots (though keeping one or two was a good experience also to see how we could take them through the process). Treating the characters differently to the environments also worked well. They would've gotten lost if taken through the same process. Trying to portray painting of such a loose nature for a story with a very clear-cut vision was certainly a little beyond us but I'm still happy that we did the project even knowing that. Having our limited skills in mind definitely helped us plan it better than I feel we otherwise would have."

Figure 3: *Viewport render of the painted texture applied to the house walls*

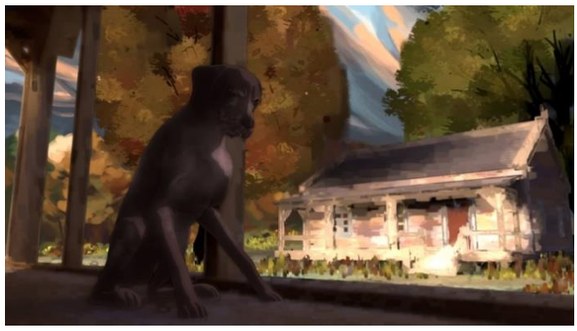

Figure 4: *Screenshot from "The Hunt" by Adele Olsauskaite, Elisabeth Wetchy and Beate Nieuwoudt (Olsauskaite et al. 2022)*

2.2 Abstract expressionistic 3D art

Given the Covid-19 lockdown, NCCA student Ashley Cornall took to experimenting with abstract expressionism in the context of the Light-in-Space movement (2021). Cornell created a 3D version of her room and created a painting on glass (see Figure 5) that she scanned (see **Error! Reference source not found.**) as used as gobo to project the light and colour onto the 3D scene (see **Error! Reference source not found.**). The rendered images were then printed on watercolour paper and painted upon further using watercolours. These paintings were then scanned back into digital space but during the scanning process, Cornell moved the paintings so that the final result produced a mechanically distorted and warped effect that resonated with the artists' experience of technology on her own life (see Figure 8).

Figure 5: *Glass painting by Ashley Cornall*

Figure 6: *Glass painting scanned to create a digital light projection map*

Figure 7: *Painting used as a light map using only transparency*

Figure 8*: "Petri Garden" by Ashley Cornall (2021)*

2.3 Exeter cathedral colour reconstruction

Digital colour reconstruction of Exeter cathedral was undertaken by Khosravi (Khosravi et al. 2022) as part of the Vista-AR (2022) case study. A 3D scanned model of the Exeter cathedral was provided by Vista-Ar. Khosravi's task was to produce a plausible, evidence-informed colour reconstruction based on a previous study by Sinclair (1995) that provided residual colour samples from within the Exeter cathedral stonework. The textured model was then used within an augmented reality app to create an immersive cultural heritage experience.

Figure 9: *Close-up of an untextured model of a stone figure on the Exeter cathedral wall*

Figure 10: *Close-up of the textured model*

Figure 11: *Untextured 3D photogrammetry scan of the Exeter cathedral wall (above) and the digitally painted model (below)*

2.4 Virtual production portrait shoot

Virtual production became hugely popular during the Covid-19 pandemic as travel restrictions came into force and studios tried to find ways of working in local, controlled environments. In summer 2021, an LED stage was created at Bournemouth University to explore virtual production best practices, challenges and constraints. A stills photography portrait shoot was undertaken as a practical experiment to explore craft best practice, plausibility of the resulting look in terms of digital and real-world light and camera match, and the challenges and benefits virtual production had to offer to photographers. The real life character was photographed against the LED screen with a range of computer generated (see Figure 12 and Figure 13), as well as photographed location backplates (Figure 14).

The studio lighting and camera attributes could be adjusted to make the real-life model sit better with the background. Alternatively, the background image or virtual scene could also be manipulated in real time to create a different look.

Figure 12: *Photographing the subject with a computer-generated environment displayed on the LED wall background*

Figure 13: *Virtual production portrait by Rehan Zia (2021)*

Figure 14: *Subject photographed against the LED wall displaying a real-world location photograph*

A second variation explored photographing the subject against a greenscreen using the LED wall a large volume light to front and side light the model (see Figure 15). The greenscreen could subsequently be replaced with the image used on the LED wall to create a more realistic light match.

Figure 15: *Photographing the subject against a greenscreen whilst being front and side lit by a real-world photograph displayed on the LED wall. The camera positioned in front of the LED wall looking towards the subject*

A third variation used the LED volume solely as a large lighting volume with the model without changing the background. This allowed the photographer comprehensive and instantaneous control over the subject lighting using the LED wall as a lighting 'canvas' to paint the colour and intensity of light to create the desired look (see Figure 16 and Figure 17).

Figure 16: *Using the LED wall as light source for front and side lighting against a greenscreen background*

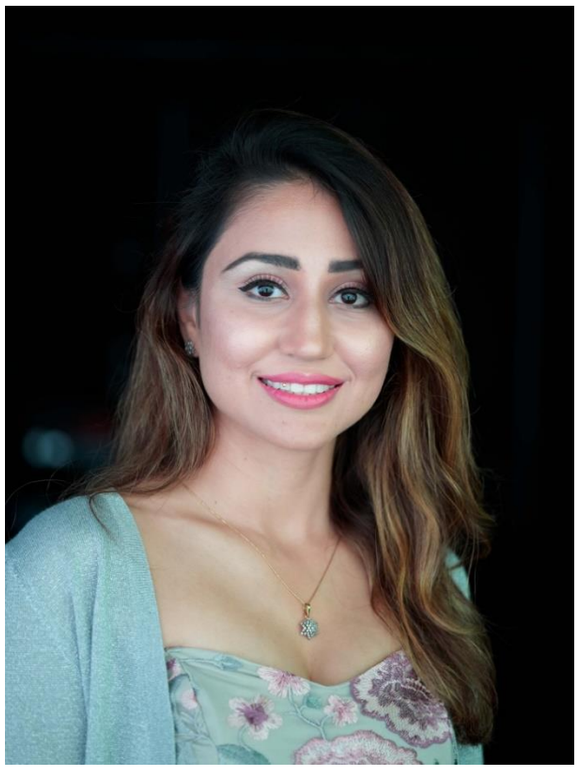

Figure 17*: Using the LED wall as light source for front and side lighting against the studio environment*

2.5 3D scanning and image-based lighting to create spatially correct photorealistic computer-generated lighting

In order to create spatially plausible light bounce, a 3D scan of two characters sitting on a bench was created by the author by photographing the scene from various different positions. A 360 high dynamic range panoramic image was also created to generate a volume light map for the computer-generated scene. A computer-generated sphere object was then placed in the scene along with a volume light mapped using the high dynamic range panoramic image (see Figure 18–20). The spatial proximity of the sphere to the bench and characters resulted in spatially accurate reflections and light bounces (see Figure 21).

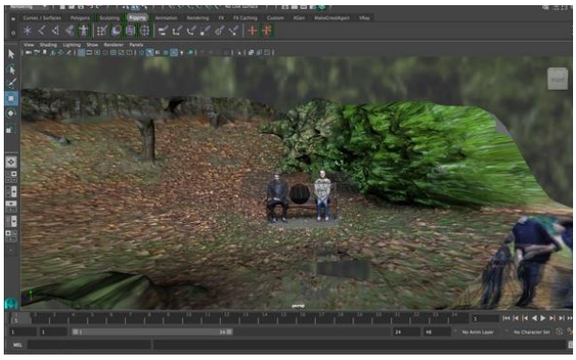

***Figure 18**: 3D scanned scene with a computer-generated sphere in between the characters on the bench*

***Figure 19**: Rendered 3D scene with all 3D objects*

***Figure 20**: The rendered sphere object on its own*

***Figure 21**: The sphere object colour corrected and composited over an actual photograph from the photogrammetry shoot*

3. THE FUTURE OF VISUALISATION AND CRAFT IN MIXED REALITY

The advancements in digital technologies, such as 3D scanning, 3D printing, virtual production, virtual reality and augmented reality, have enabled artists unprecedented control over the interchangeability of material states across the analogue and digital domains. The artist now has the control to seamlessly switch between these domains based on where they feel the operation at hand could be better accomplished. The digital and analogue has thus become fluid. It would be very interesting to see the fusion of analogue and digital craft practices as these technologies become more affordable and commonplace.

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Exeter Cathedral: A colour reconstruction for use in augmented reality devices

Maral Khosravi
Bournemouth University
Poole, UK
mkhosravi@bournemouth.ac.uk

Rehan Zia
Bournemouth University
Poole, UK
rzia@bournemouth.ac.uk

Jian Chang
Bournemouth University
Poole, UK
JChang@bournemouth.ac.uk

In this paper, we present a digital craft-based approach for 3D colour reconstruction that utilises high-quality texture maps applied to low poly triangulated meshes for augmented reality applications. We present a case study based on a scanned 3D model of the Exeter Cathedral west front which was digitally painted to recreate the colours that had existed on the real building centuries ago. These colours were informed by previous research into remnant colour samples collected from the building stonework. The manual digital painting process based on a reference study of the actual colour samples from the building stonework allowed for a colour representation that is very close to the original colours that existed on the stonework. This project was developed to be used as an augmented reality application case study for the VistaAR project. In order to ensure optimal viewing experience, highly detailed textures were applied to low poly triangulated meshes that could be zoomed into by the viewer without compromising significant details ensuring a good immersive experience for the viewer.

Digital colour reconstruction. Augmented reality. Digital heritage.

1. INTRODUCTION

In this paper, we present and explain the task of digitally painting a reconstructed model of Exeter Cathedral west front by Eddie Sinclair (1995), a specialist in the protection and investigation of historic pigmentation surfaces. The task of painting the reconstructed model was broken down into four steps; The first step consisted of cleaning up the scanned model of the Exeter Cathedral to create a good surface model. This step is most critical as it ensures there are no issues further down the production pipeline. The second step is the construction of UV tiles for the 3D model. This is the most important element for the colouring and texturing for 3D models as it allowed us to divide a large scanned UV model into six different parts of the same size. The third step consisted of creating normal maps that allow for a reduction of the triangle mesh size of the 3D model whilst keeping as many details as possible. The final step consists of analysing and painting all large and small parts of the cathedral; each individual part of which has its own colour; This painting was done manually in Substance Painter.

1.1 Digital colour reconstruction

Digital colour reconstruction (DSR) is the process of painting the surface of the 2D or 3D model to bring back the look of the original or previous real-world state that may not exist anymore (Pappas et al. 2000). DSR facilitates preservation of cultural heritages site (Stanco et al. 2011). because this process can be used to bring back the colours that existed on buildings, archaeological sites or objects in the past but have since faded away. This process can also be used to visualise what the object may look like in the future by tracking the deterioration state and making informed guesses. DSR offers many advantages: a) the data is handy to be analysed and reused by site managers and academics, b) it removes the access barrier and can be integrated with recent VR and AR technologies, c) the digital data can preserve the artefact well which will not prone to the damage of time and weathering, d) the digital replication can be duplicated and shared among different stakeholders (such as museums, universities, and the general public) to open new possible applications (Rambaran-Olm 2013).

2. AIM AND OBJECTIVES

The aim of this project was to create a realistic and engaging viewer experience for a digital walkthrough of the Exeter cathedral. The key objectives were a) to do colour reconstruction for the 3D scanned model of Exeter cathedral based on true references provided by Sinclair (Sinclair no date), and, b) ensuring that the textures were detailed enough to be engaging for the viewer whilst also being optimised for AR applications.

3. COLOUR SAMPLING

The colours were informed by prior colour samples collected by Sinclair (1995) from the Exeter cathedral stone work. Matching the specific colours was a difficult task because the two-dimensional reference provided to us itself added another additional level of the colour's separation from the original. Additionally, the remnant colours were already faded over time and obtaining accurate colour samples of the colours as they would have looked when painted fresh was challenging. Therefore, the colours whilst informed by Sinclair's work, still lacked a level of accuracy. We used colour the sampling tool in Substance Painter which resulted in over fifty layers being generated for each part of the model that were hand textured by us and exported as a single 8K x 8K image file texture.

4. PRODUCTION PROCESS

The project requirement was to create the best quality visual experience for the augmented reality application. Given that the scanned model provided was quite detailed and huge in terms of file size, we tested with a number of different texture mapping techniques and texture sizes. We found that dividing the model into three parts and using two UV maps for each part gave us the best control in terms of managing the texture painting and mapping processes. For this reason, we created six 8K x 8K texture maps that were applied to each UV space respectively. We had initially started off with two scan models of Exeter Cathedral.

4.1 3D Scanned models

The first model (see Figure 1) had 30000000 faces, was extremely detailed, high quality had a very high number of triangulated meshes and was very precise. The high poly count introduced other challenges such as long scene load-up times and frequent crashes. The second model (see Figure 2) was more optimised having lower polygon meshes compared to the first model with 1853556 faces. It was, therefore, easier to work with as the digital editing processes and operations would run more smoothly requiring less scene load and wait times and was simpler to manage in Maya (Autodesk 2019) as well as other texture painting software. The third model (see Figure 3) was created by reducing the poly count on the second model to 603903 faces in order to allow for an appropriate size and was deemed to be the best compromise to be used for AR device applications with 6 – 8k x 8k texture maps.

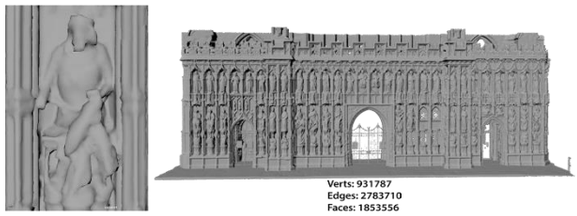

***Figure 1**: First and heaviest scan model for Exeter Cathedral west front model*

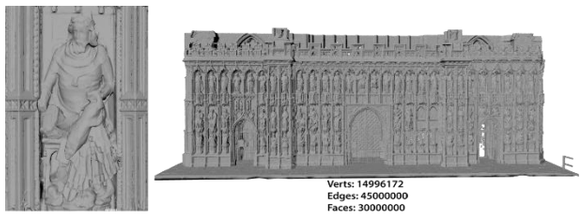

***Figure 2**: Second scanned model of Exeter Cathedral*

***Figure 3**: Third and final integration model we have reduced it for augmenting really devices*

4.2 UV tile

In the third scanned model, many sections of the model had broken vertices, non-manifold geometry, and extra polygons that had to be fixed before the digital painting could start. The scale, polygon count, and file size of the model was a growing concern. To combat this, I separated the model into three individual parts (see Figure 4) as it was easier to manage. The reasoning is that if it was one model, the UV map would be very large and time-consuming to create as well as to manage. We used six UV tiles for each of the six texture maps. We separated the Exeter Cathedral model into three sections where, each section used two UV tiles which allowed the export of two texture maps per section (see Figures 5 and 6). To make sure all the textures had the same resolution, the biggest UV shells were kept at the same size. The faces and the clothing of the statues had to be

separated from the walls so that they could be more detailed.

Figure 4: *Separate Exeter Cathedral model into three different parts*

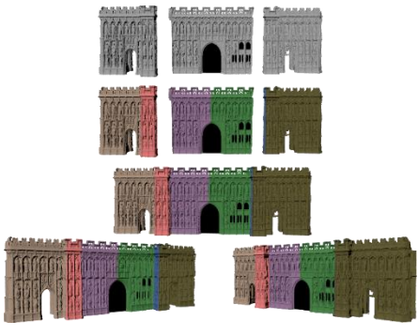

Figure 5: *shows which parts of each section have been divided for using two texture maps*

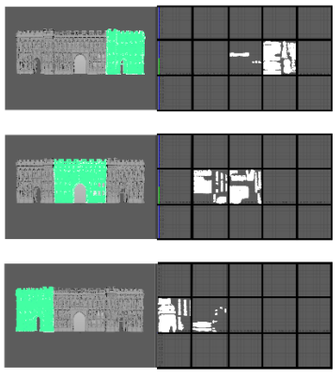

Figure 6: *Screenshot from Maya scene that shows UV tiles for each section*

4.3 Normal maps

To create details for the final model, we used the first scanned model to generate normal maps which enhanced the details of the 3D model without having to add polygons. For this process, we utilised Substance Painter (Adobe 2022). Substance Painter was chosen over Maya and ZBrush (Alon & Rimokh 2019) as it allowed for creation of normal maps without having to have the same UVs across each model.

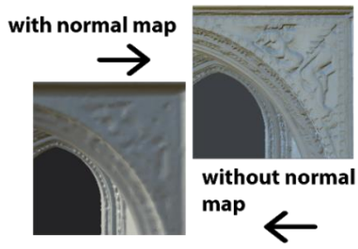

Figure 7: *Comparison with and without normal map*

4.4 Digital colour paint for Exeter Cathedral west front

We used some interest references as well acquire the base stone colour, tones and details and created a stone material that acted as a base replica of the actual stone. This was used where some parts of the statue were broken. and where we were unable to colour those sections. For these broken sections, we resorted to opting for the original brown making sure to layer the colour above the base. In order to ensure better control over the texture mapping process, we split each part of the model into two different UV sections and used fill layers for each colour; having a layer for each colour makes it much easier to manage and allows for control needed to change the metalness, roughness, or heightmap. We used alpha textures to recreate patterns and used a normal brush to paint in general.

Figure 8*: Screenshot from Maya scene that shows the base and the actual colour when zooming in augmented reality devices*

***Figure 9**: The final colour of both digital and base reconstruction*

5. CHALLENGES

The first and biggest challenge in this project was the size and detail of the 3D scan of Exeter cathedral. In order for it to be manageable, we had to decrease the size of the mesh; the face of the statues themselves was already small to begin with, so whenever we reduced the mesh detail, we would lose key aspects of the face such as the nose, eyes, lips etc. Furthermore, these statues were made centuries ago so many of the key aspects were lost or had deteriorated over time such as limbs or other body parts breaking off. Due to the combination of these issues, reducing the mesh detail meant compromising the limited features on the statue faces and form. In order to resolve this issue, we used normal maps generated from the high-resolution mesh that we applied to the lower resolution mesh.

The second challenge was the impact of the size of the UV tiles on image resolution – larger UV tiles provide better resolution but at the cost of memory overhead due to the high-quality texture maps being
applied using image projection. Given that the model was being made for an augmented reality application, the UV tiles had to be kept small; we had to separate the whole model into four separate parts which meant creating four separate UV tiles. Given the small size of the UVs, all textures had to be hand-painted to ensure good resolution rather than resorting to 2D image projection that did not work very well for UVs of this size.

Figure 10: *This is a screenshot of a video posted by Vista AR on YouTube showing how colours look like on augmented reality devices, it should be noted here that the colours look blurry, but when you hold the augmented reality devices and zoom in, the colours are quite clear.*

6. CONCLUSION

In this paper, we have presented a digital craft-based approach to use high-quality texture maps in reconstructing a scanned 3D model for augmented reality devices. Given the size, detail and high poly count of the scanned model, the digital texturing and painting process proved challenging due to which we devised a more game-based approach of using a low poly model with high-quality textures and normal maps to ensure the final images appeared detailed and engaging when viewed in the VistaAR app. The digital texturing and painting were primarily done using Maya, Substance Painter, Zbrush, Photoshop (Faulkner et al. 2019) and Unity (Unity 2022) This approach can be improved further and utilised extensively for similar augmented reality and virtual reality digital heritage reconstruction applications where the scanned model sizes are very large.

7. ACKNOWLEDGEMENT

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My Data Body

Marilene Oliver
University of Alberta
Edmonton, Canada
marilene@ualberta.ca

J.R. Carpenter
Unaffiliated
Settle, England
carpenter@luckysoap.com

Scott Smallwood
University of Alberta
Edmonton, Canada
ssmallwo@ualberta.ca

Stephan Moore
Northwestern University
Chicago, United States
stephan@northwestern.edu

1. INTRODUCTION

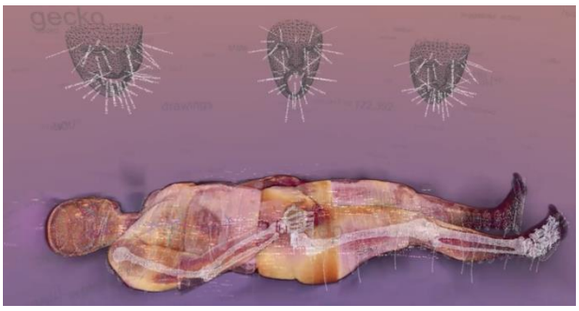

Figure 1: *My Data Body, screenshot from VR experience*

My Data Body is a virtual reality (VR) artwork created at the University of Alberta as part of the interdisciplinary research creation project *Know Thyself as a Virtual Reality*. The project which developed from a previous artwork *Deep Connection* (Oliver 2021) brings together different forms of personal data such as medical scans, social media, biometric, banking and health data in an attempt to make visible and manipulable our many intersecting data corpuses so that in VR they can be held, inspected and dissected. In *My Data Body*, the medically scanned, passive, obedient, semi-transparent body (Cartwright 1995) becomes a data processing site that can be pulled apart, de- and re-composed or as Yuval Harari warns 'surveilled under the skin'.

2. MY DATA BODY VISUAL ELEMENTS

In My Data Body, the magnetic resonance (MR) scanned body of artist Marilène Oliver floats prone within a cloud of Oliver's textual Facebook data. Into the semi-transparent, virtual body are multiple other data corpuses downloaded from social media platforms plotted into cross sections of the body. In the horizontal plane, Mac terminal data is plotted into bone, Google data into muscle and Facebook data into fat. In the vertical plane are plotted data usage agreements and into the depth plane are texts from various data privacy charters. Passwords and logins flow back and forth through veins and arteries, whilst high resolution retinal and dental scans and meshes of organs and bones are suspended within the quantified and datafied body (Lupton 2016).

Figure 2*: detail showing textual cross sections*

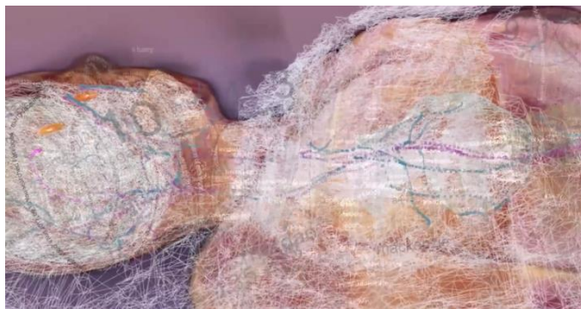

Figure 3: *My Data Body detail*

To echo historical anatomical public dissections, there is an audience of Oliver's facial recognition scans wearing different emotions captured using an iPhone circling the body. Also recalling Renaissance anatomy and myths of Franciscan nuns performing dissections in order to find evidence of saintliness (Park 1994), Oliver's 'SIN' (social insurance number) is pinned to her coccyx. This deeply hidden digital 'SIN' points to contemporary online cancel culture where a single post or tweet demonize the author forever. The *My Data Body* 'dissection theatre' is bathed in a blend of volcano ash lavender (Bridle) to forest fire orange in order to recall the immense amounts of

energy needed to generate and process data and the impact this has on climate change (Mullaney 2021). At a touch of the VR controller's buttons, *My Data Body* can be enlarged or shrunk so that the user can be engulfed in *My Data Body* or hold it miniscule in their virtual hands. As the body of the user interfaces with *My Data Body* (Hansen 2006) it both invades and possesses it.

3. DECOMPOSITION OF MY DATA BODY

Figure 4: *sonic relocation in a data mask*

Each of the elements in *My Data Body*: the scan data, organs, bones, cross sections can be extracted from the body, inspected individually elsewhere in the scene. Sound works created by Scott Smallwood and Stephan Moore that incorporate biometric digital recordings of Oliver's voice and heartbeat as well as textural sound (such as scratching, gurgling, squelching and resonances) are attached to each of the elements so that as *My Data Body* is dissected visually and spatially, it is also 'de/re-composed' sonically. Indeed, the sound composition is only created as bones, organs and slices are extracted. The skeleton for example is a sound composition fractured into 8 parts that is solely experienced by removing the bones from the body and piling them in a heap outside of it. Furthermore, using the gamification potential of the VR medium, bones, organs and slices are all programmed to return to the body after a certain time of inactivity, so there is the time pressure to extract and resituate the data in time to hear it. Also using the medium's unique ability to sonically reposition the listener, each of the facial scan masks that surround *My Data Body* has Oliver's voice reciting personal her data at different pitches that the user can cycle through using buttons on the controller giving the sense of being trapped in a dizzying electronic melody.

3. POETRY EMBEDDED INTO MY DATA BODY

Poetic text written by J.R. Carpenter flows through and dangles from *My Data Body*. Carpenter composed poetic verse for each of the bones so that when the bones are pulled out of the body it can rotated and read. From the ribcage for example hang the phrases: *I dream I hear a body sleeping, in the bed beside me. But it's only the wind, big ribs rising and falling. It's only the house, breathing through its nose.* Pasted into the back of the retinal scans are the words: *(I cannot imagine a mark on my body any deeper than the memory of text burned into my retina, left smouldering in my brain).*

Figure 5: *underside of retinal scans*

A stream of text particles washes over and through *My Data Body*. For this Unity's particle system typically used to simulate smoke, clouds or fire effects, was repurposed to generate free verse poetry. Unity's particle effects are generated from gridded image files which are sub-divided and sequentially emitted from a specific location in the scene with various speed, colour, transparency and direction settings. Carpenter used the form of a 4 x 4 grid to create two particle streams of text that pass through *My Data Body* to socially and historically complicate and sensualise the datafied corpuses of *My Data Body.*

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Book Launch: *Explosions in the Mind: Composing Psychedelic Sounds and Visualisations*

Jonathan Weinel
School of Computing and Mathematical Sciences
University of Greenwich
London, UK
J.R.Weinel@greenwich.ac.uk

1. INTRODUCTION

Explosions in the Mind: Composing Psychedelic Sound and Visualisations (Weinel, 2021) is a new book exploring more than a decade of the author's practice-led research composing sound and visualisations based on altered states of consciousness such as hallucinations and experiences of synaesthesia (Figure 1). The book is part of the Palgrave Studies in Sound series, edited by Prof. Mark Grimshaw-Aagaard.

From electronic music performances to fixed-media audio-visual compositions, interactive projects with game engines, VJ performances, and virtual reality applications, the projects reflect a wide-ranging exploration of approaches for composing sounds and visualisations based on psychedelic states. The book presents a detailed commentary of these works, supported by an extensive number of colour images, as well as supporting media files including sound recordings, videos, and software examples, which readers can download and explore alongside the text.

Many of these projects have been featured in previous papers and demonstrations at the *EVA London (Electronic Visualisation and the Arts)* conference series, which has been instrumental in shaping the development of this work, and so it is fitting that the book should now be launched at the conference.

2. THREE NEW DESIGN FRAMEWORKS

The chapters of the book discuss the compositional methodologies and technical approaches used to realise these projects, which engage with various aspects of sound design, visual art, and creative coding across a range of media.

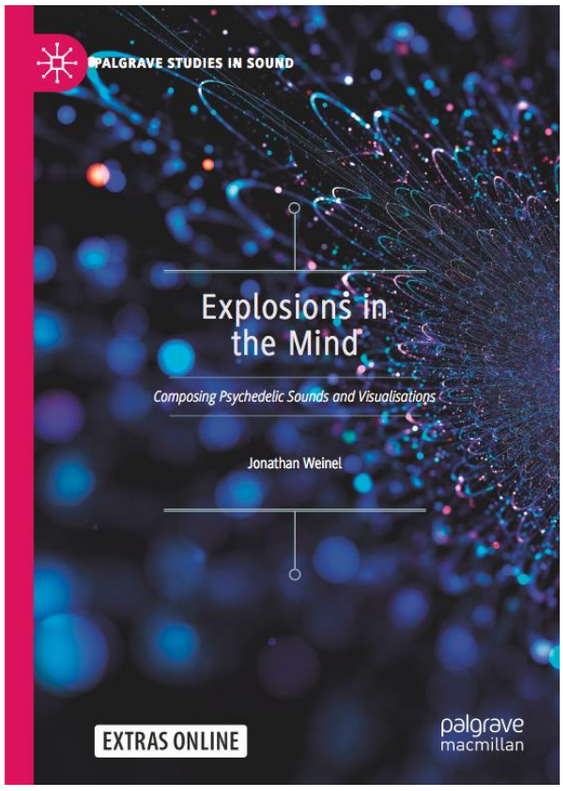

***Figure 1**. Book cover of Explosions in the Mind.*

In bringing these together, the book ultimately proposes a set of three new design frameworks that can be used for composing psychedelic sounds and visualisations. These are as follows:

- Framework for composing psychedelic journeys in sound

- Framework for designing altered states of consciousness simulations
- Framework for composing synaesthetic visualisations of sound

These frameworks summarise the approaches used throughout the body of work discussed in the book, and indicate possible approaches which can be used an adapted by other artists and researchers working in this area. The presentation at the conference will provide a rapid tour through the spectrum of work that informed these frameworks, before outlining the key features of each.

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Cymatic patterns of the Black Cockatoo: Visualising the calls of wildlife in Australia

Leah Barclay
University of the Sunshine Coast
Sippy Downs, QLD, Australia
lbarclay@usc.edu.au

Tricia King
University of the Sunshine Coast
Sippy Downs, QLD, Australia
tking2@usc.edu.au

Lyndon Davis
Gubbi Gubbi Dance
Sunshine Coast, QLD, Australia
gubbimob@hotmail.com

Beeyali is a research project exploring new methods for visualising the calls of wildlife on Kabi Kabi Country, the traditional lands, and waters of the Sunshine Coast in Queensland, Australia. The project brings together Indigenous knowledge, environmental research, emerging technology, photography and sound to visualise wildlife calls using cymatics, the science of visualising acoustic energy or sound. The first phase of the project focuses on the calls of Black Cockatoos through a series of experiments to reveal cymatics with organic materials and digital technology.

Cymatics. Photography. Acoustic ecology. Sound. Projection art. Indigenous knowledge.

1. INTRODUCTION

The Sunshine Coast region in Queensland, Australia is home to a diversity of wildlife including iconic Black Cockatoos that are currently facing a range of threats and challenges. The impacts of climate change and habitat loss from bushfires, draughts and urban development have resulted in select species of Black Cockatoos classified as vulnerable for extinction. Acoustic methods are now being engaged to monitor Black Cockatoos and inform conservation efforts, this includes large-scale spatial and temporal mapping and specialised projects such as exploring how nestling vocalisations change through time (Teixeira et al. 2021). Community engagement is essential in wildlife conservation and acoustics offer various interdisciplinary pathways to understand vulnerable species in new ways.

Black Cockatoos feature heavily in First Nations song, dance and visual arts in the Sunshine Coast region and have been an inspiration for internationally recognised Indigenous artist Lyndon Davis for over a decade. Davis paints traditional patterns referencing flora and fauna from the Sunshine Coast and was particularly interested in exploring how the visual representation of wildlife calls correlated with geometric patterns associated with Indigenous designs, to demonstrate ecological interconnection.

Figure 1: *Lyndon Davis with Cockatoos*

Working in collaboration with sound artist Dr Leah Barclay and photographer Dr Tricia King, Davis conceived *Beeyali* – a research project exploring new methods for visualising the calls of wildlife on Kabi Kabi Country in Australia.

Beeyali is a Kabi Kabi word meaning 'to call' and the project brings together Indigenous knowledge, environmental research, emerging technology, photography and sound to visualise the calls of wildlife using cymatics, the science of visualising acoustic energy or sound. The pilot phase of the project was commissioned as a large-scale projection work for NEW LIGHT 2021 – a competitive national award from the Australian Network for Art and Technology (ANAT) supporting experimental and diverse moving image works by contemporary First Nations artists.

The first phases of the project focussed on the calls of cockatoos and involved a series of experiments to reveal cymatics with native flora, ochre, water, Kabi Kabi designs and digital photography. The research team explored ways to create digital cymatics using photography of the Black Cockatoos as the source material in pattern generators activated through sound.

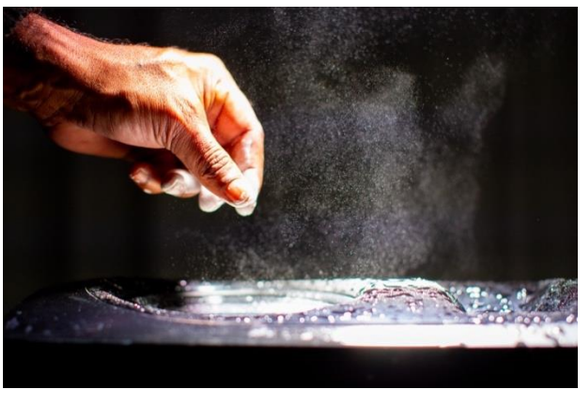

Figure 2: *Beeyali cymatic experiments with cockatoo calls vibrating with water and orche*

This resulted in the development of new techniques for sonic visualisation that have informed a body of audio-visual creative works featuring large-scale projections that are introduced throughout this paper. The dynamic geometric patterns respond to audio and have developed new knowledge in cymatics with original processes that combine acoustic ecology, photography and Indigenous knowledge. This technique is applied to wildlife calls to inspire the conservation of biological and cultural diversity through creative practice. The *Beeyali* project will expand in 2022 and is designed to explore connections between cultural and environmental knowledge to inspire climate action, environmental empathy and interdisciplinary processes that intersect Indigenous knowledge, science, creative practice, and new technology.

Figure 3: *Beeyali – live projection performance for Floating Land 2021, Noosa Biosphere Reserve*

2. CYMATICS

Cymatics is an interdisciplinary field studying the visualisation of acoustic energy (Jenny 1967). It is a technique emerging from Hans Jenny's experiments in the 1960s using powdered materials scattered across a surface that generated distinctive and complex patterns when activated with sound waves.

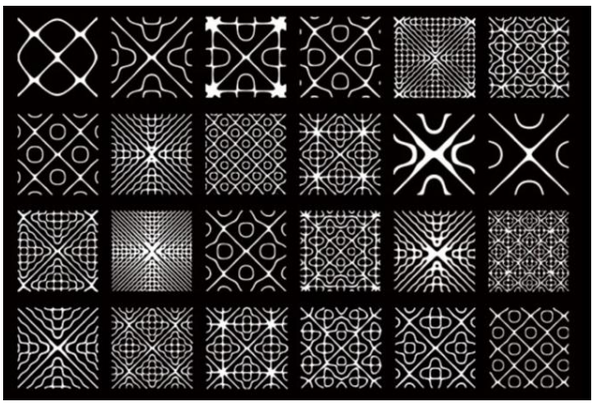

Figure 4: *Cymatic patterns – sound visualisations*

He discovered that particular frequencies pulsated and shifted the materials into rich and dynamic patterns. When sound activates these liquids and materials the vibrations create kaleidoscopic movement and geometric patterns.

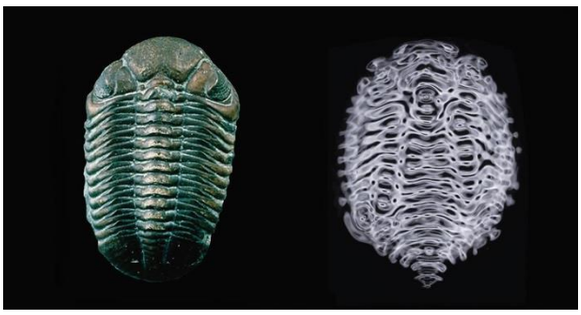

Figure 5: *This cymatic image shows a marine trilobite fossil, from an early Cambrian period, circa 526 million years old on the left and the right shows a trilobite pattern appearing through cymatics (created with a CymaScope by John Stuart Reid).*

Jenny (1967) was the first to suggest links between cymatics and the environment, with striking similarities between the geometric patterns emerging and naturally occurring principles and patterns in ecosystems. This resonates strongly with Indigenous notions of environmental interconnection and was the fundamental inspiration for the *Beeyali* project. Connections to cymatics and environmental geometry are evident in the complex patterns of many Indigenous art traditions in Australia. Lyndon Davis believes that everything is connected in our local ecosystems

and these patterns can help to tell a story about what is happening in our environment. Lyndon's interest in cymatics were initially through watching sand vibrate on resonant brass plates played with a bow creating different geometric patterns known as the Chladni figures which were documented in Ernst Chladni's book *Discoveries in the Theory of Sound.* Davis was inspired by the ways the geometric patterns connected to his painting style and wanted to explore the relationships between sound and geometry in his work.

Cymatics has inspired various creative projects and collaborations including mainstream projects such as live visuals for Björk's Biophilia tour created by visual artist Meara O'Reilly. Richard Grillotti (2021) led the project 'Resonant Waves' – an interactive installation that incorporates cymatic patterns to reveal the complex symmetrical shapes of sound. This multisensory artwork generates and processes wave interference patterns that are translated into dynamic geometries across different modalities. Participants simultaneously hear, feel and see the patterns created when a carefully selected range of sound frequencies generate motion in water. Photographer Linden Gledhill has also drawn inspiration from cymatics with a background in science which has led him to use advanced microscopy and high-speed equipment that reveals cymatic patterns and perspectives that are usually invisible to the human eye.

3. RESEARCH TEAM: LISTENING IN THE WILD

The creative team behind this project bring unique skills to the collaboration that contribute in various ways. The trio first worked together on *Listening in the Wild* – a series of immersive soundscapes and site-specific photography exploring environments across the Sunshine Coast commissioned for Horizon Festival 2020 and produced as remote experiences in response to the Covid-19 pandemic. Through virtual sound walks along Eudlo Creek, Maroochy River and Old Woman Island interwoven with Kabi Kabi stories, this project investigated how remote embodied experiences of natural environments can facilitate ecological empathy, cultural knowledge and connection to place. *Listening in the Wild* builds on a large body of research in immersive media art responding to ecological crisis and climate action (Gilmurray 2017).

Under the cultural guidance of Kabi Kabi artist Lyndon Davis, *Listening in the Wild* explored new ways of using virtual technologies with live soundscapes and site-specific photography to connect audiences to locations and cultural knowledge across the Sunshine Coast. The project developed new tools for streaming audio in a high-quality format and asked how we can appropriately and effectively use audio-visual experiences to connect communities to place and develop a deeper understanding of cultural and environmental knowledge. The project was part of a portfolio of research exploring the possibilities of live streaming technologies to facilitate environmental connection during global Covid-19 lockdowns. *Listening in the Wild* was awarded the 2021 APRA Art Music Awards for Excellence in Experimental Music with comments including 'This project is spearheading the way forward for future Australian sound art and is a quality model for all to follow'. This research project was the starting point for the Beeyali collaborative team and revealed how our unique skillsets can work together.

Dr Leah Barclay is a sound artist, composer, designer and researcher who works at the intersection of art, science and technology. Barclay's research and creative work over the last decade has investigated innovative approaches to recording and disseminating the soundscapes of terrestrial and aquatic ecosystems to inform conservation, scientific research and public engagement. Her work explores ways we can use creativity, new technologies and emerging science to reconnect communities to the environment and inspire climate action. Barclay's research is designed to advance the field of acoustic ecology and ecoacoustics to demonstrate the value of sound in the environment (Barclay 2020) .

Dr Tricia King is an active documentary photographer. Her research focuses on photography, its role in personal and cultural memory, and the construction of identity. Utilising techniques like photo-elicitation, documentary and collaborative photography, Tricia develops collaborative participant driven projects working predominantly with people experiencing social isolation. Most recently she has worked with older people living in aged care to explore their lived experience and help develop programs to assist with greater socialisation (King 2021).

Lyndon Davis is a direct descendant of the local Kabi Kabi people, traditional custodians of the Sunshine Coast region. In 1995, Lyndon founded the Gubbi Gubbi Dance troupe, bringing together a group of young Indigenous artists and musicians from the Sunshine Coast, presenting local Traditional Aboriginal Song and Dance. The dance troupe are now one of the most in demand Aboriginal performance groups in Queensland and are regular performers at major events. In addition to his performance work, Lyndon is an active visual artist, painting the stories of his homelands and the connection between people, the land, the animals and spirituality. Over the past years, he has worked with anthropologist Dr Ray Kerkove researching the

local traditional designs of Southeast Queensland and incorporating a contemporary form into his artwork, acknowledging the Aboriginal art styles from this region. His visual art is held in national and international collections, and he has been commissioned by various high-profile organisations, museums and art collectors. Davis' experimental art practice has been featured at major festivals with immersive installations and large-scale projections commissioned for Horizon Festival, Floating Land, ANAT and Illuminate Adelaide.

Figure 6: *Beeyali creative team working in the studio*

4. LISTENING TO ECOSYSTEMS

The impacts of climate change are becoming increasingly visible and audible in ecosystems across the planet. Scientists continue to sound the alarm and we urgently need more effective ways to engage communities in conservation and climate action. There is still much to learn about the interconnected nature of the planet's ecosystems and many remote locations still lack basic species inventories. Conventional environmental monitoring that requires scientists to travel for field work is highly invasive and has not been practical or possible during the COVID-19 global pandemic. This style of environmental monitoring is also constrained to restricted areas and manual processing of observations which can often generate bias results (Linke et al. 2018). Listening to changing ecosystems with remote audio recorders offers a transformational opportunity to monitor remote environments and engage communities in the process. Acoustics can help inform environmental management decisions and accelerate conservation efforts (Teixeira et al. 2021).

Rapid advancements in acoustic technology mean we can now monitor changing environments through accessible, affordable, and non-invasive acoustic sensors. Innovations in hardware and software mean that acoustic monitoring can be conducted by local communities and offers a viable method for measuring ecological changes and monitoring biodiversity (Deichmann et al. 2018). Ecoacoustics draws on acoustic ecology, a well-established interdisciplinary field that emerged in Canada in the late 1960s.

Ecological sound artists emerging from the acoustic ecology movement have propelled many of the most significant discoveries that have informed the development of ecoacoustics. Their nuanced understanding of our sonic environment and knowledge that sound can engage communities and listeners at a deeper, more attuned level strongly aligns with the interdisciplinary intentions of ecoacoustics and the foundations of acoustic ecology. Immersive sound installations and performances drawing on recordings from ecosystems have been successful in evoking empathetic and philosophical responses to climate change that can inspire ecological action in communities (Monacchi 2013; Burtner 2011). Ecological sound art performances are regularly presented with visualisations, most often in the form of spectrograms providing a direct representation of the sound.

Ecological sound art presented in a collective listening experience can create metaphors to help communities connect with environmental issues on a deeper and more personal level. These creative works can immerse communities in a remote ecosystem and inspire awareness and respect for invisible or inaccessible areas of the environment that they would not traditionally be able to access (Gilmurray 2017). Visualisations of sonic environments provide another sensory connection to this process.

Figure 7: *The Great Animal Orchestra – Bernie Krause (spectrograms of environmental soundscapes)*

Salomé Voegelin (2014) believes that when communities engage in these collective listening experiences it is possible to become submerged is a 'sonic possible world' where personal listening experience can inspire communities to think

differently about the environment. The intersection and relationship between sound and visuals in this context warrants further exploration and has inspired various creative approaches in the initial phase of Beeyali research.

5. BEEYALI CREATIVE PROCESS

Beeyali brings together Indigenous knowledge, environmental research, emerging technology, photography and sound to visualise to calls of wildlife using cymatics. The project was developed throughout 2021 with the pilot phase commissioned as a large-scale projection work for NEW LIGHT 2021 – a competitive national award from the Australian Network for Art and Technology (ANAT) supporting experimental and diverse moving image works by contemporary First Nations artists. The initial phase of the project involved field work to generate audio recordings and photographs of the Black Cockatoos and observe the cockatoos in different contexts, including direct interactions with cockatoos in captivity and field observations in the wild.

Observing and recording the Black Cockatoos both in captivity and in the wild allowed the team to study the natural movements and rhythm of the birds over both close and distant proximities. These varying spatial observations highlighted the diversity of movement, colour and sound of the birds, allowing the examination of the intimacy of small, detailed movements such as the ruffling of feathers or unique vocalisations, as well as the majestic gliding motion of the birds in full flight.

Figure 8: *Beeyali field work with Black Cockatoos*

In the wild, the birds were observed on the Sunshine Coast and recorded in Noosa Biosphere Reserve with remote audio sensors installed for long durational field recording. Working within the large-scale aviaries of a Sunshine Coast bird rescue sanctuary, juvenile and adult black cockatoos living in captivity were photographed and recorded. Many of the birds were socialised to fly to humans which allowed the team to connect, touch and converse with the birds intimately. Black Cockatoos have complex social behaviours, and so the ability to observe at close proximity allowed greater insight into nuances around their communication and behaviour with both humans and each other.

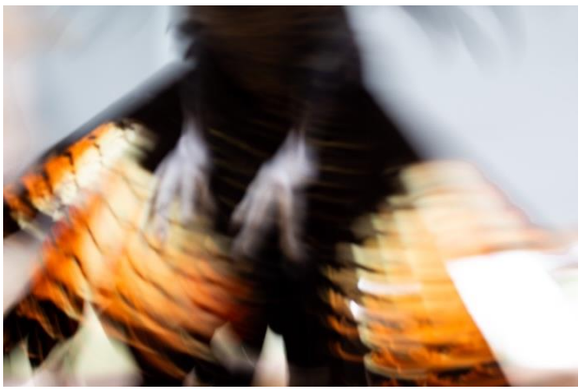

Figure 9: *Black Cockatoo tail feather in flight*

The approach to photographic work was to both record the patterns of the birds and their locomotion. Images such as Figure 9 shows the feet and tail feathers of a black cockatoo in flight just after leaving a branch. Using a slow shutter speed on the camera to allow small but significant movement of the bird, the patterning becomes blurred to show the blending of the colours as the bird moves through the air. The natural eye cannot perceive the blending of the colours in such a way, so the photograph allows the recording of this colour shift and provides a visual image which directly informs our knowledge of how the patterning of the bird changes with the movement of flight. This image evokes the patterns of an audio spectrogram and references the movement and vibrations of cymatics.

The socialised birds of the rescue sanctuary displayed strong characteristics which we have come to understand of Black Cockatoos and indeed many parrots in general. They climbed over the equipment and inspected (and pecked at) any object or person introduced to their environment – swarking and flying from person to person. The intimacy of the encounter into their environment allowed connections to be made between the birds and the individual team members. This connection is evident in Figure 10, where the Black Cockatoo has made direct connection and eye contact with the photographer. In this way, the image more closely resembles portraiture than wildlife photography as we get a clear connection between the photographer and the sitter. The detail in this image, particularly in the chest feathers and eye, inspired the research team to explore digital cymatic experiments, using the photograph as source material in generative audio visualisations.

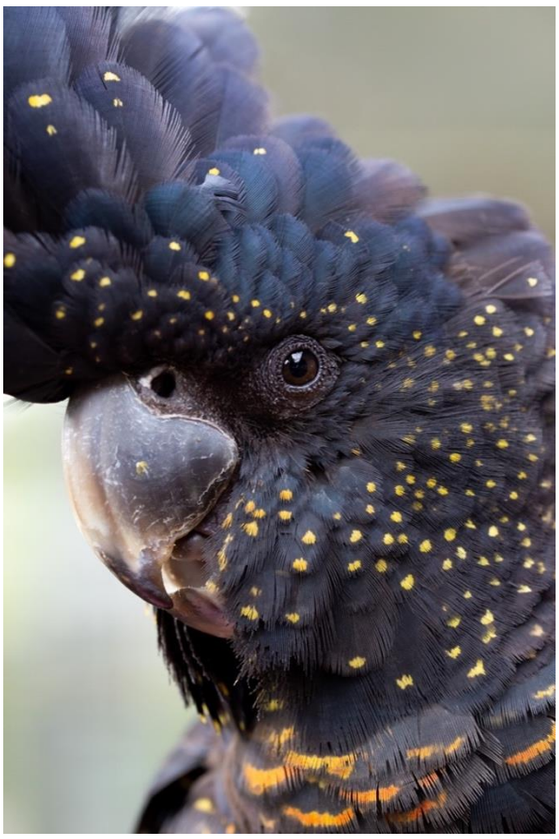

Figure 10: *Photograph of a Black Cockatoo during field work that was used as source material during the following digital cymatic experiments.*

Through a series of experiments using digital photographs (including Figure 10), the research team developed experimental techniques for digital cymatics using the audio recordings of cockatoo calls to filter images in real-time using generative geometric patterns.

Figure 11: *Beeyali digital cymatic experiments*

This was an intuitive process that was instigated by the clarity and detail in the photography and the field work observations by the team. Short audio recordings of vocalisations were edited and used to filter the image in real-time to create the geomatic patterns which we coined as a form of digital cymatics.

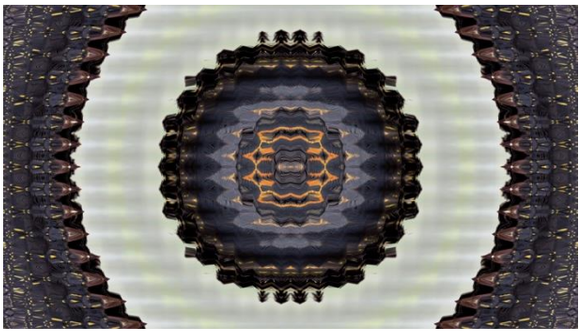

Figure 12: *Beeyali digital cymatics – Bunya Trees*

This most fascinating result of these experiments were cultural symbols emerging in the patterns. In Figure 12, the feathers and eye of the cockatoo become a rippling cymatic pattern where landscapes and trees emerged in the imagery. Lyndon Davis immediately referenced the four small trees as Bunyas – culturally significantly trees on Kabi Kabi Country in the Sunshine Coast region.

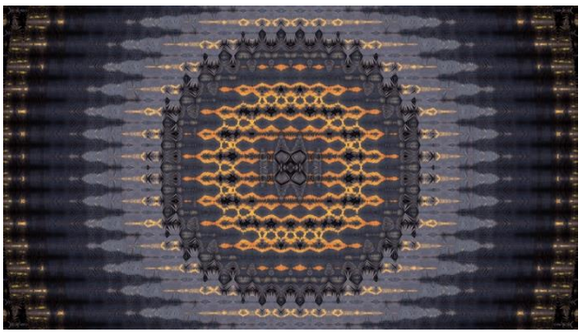

Figure 13: *Beeyali digital cymatics – cultural patterns*

In Figure 13, the pulsating geomatic patterns are responding to the cockatoo calls and referencing cultural shields and other significant imagery. This process revealed a natural intuitive interconnection between the computational processes and the environmental locations of the work.

The digital cymatics were accompanied by traditional cymatic experiments in the studio that were documented in various ways. Photography is a 2D object which does not record movement but rather implies it, allowing the photographer to control how movement is perceived. This is primarily achieved through the use of long or slow shutter speeds. In contrast to the way in which the birds themselves were photographed using a long shutter speed to blur and signify movement, during the cymatic experiments the movement projected through their calls was recorded quite differently but to the same effect of visualising the movement. A fast shutter speed was used to “freeze” the

droplets of water and ochre as they were propelled into the air from the sound of the cockatoos and this action of freezing allows the movement to be implied.

Figure 14: *Beeyali cymatics with water*

Figure 14 shows the photographing of cymatics using water and Figure 15 shows cymatics using ochre mixed with water in the speaker cone. These photographs are integrated with the digital cymatics to inform large-scale projection artworks.

Figure 15: *Beeyali cymatics with orchre*

6. CONCLUSIONS

Beeyali has resulted in the development of new techniques for sonic visualisation that have informed a body of audio-visual creative works featuring large scale projections that were produced through these experimental processes. The dynamic geometric patterns respond to audio and have developed new knowledge in cymatics with original processes that combine acoustic ecology, photography and Indigenous knowledge.

These new techniques are applied to wildlife calls to assist in new methods for the conservation of biological and cultural diversity and inspire climate action, environmental empathy and interdisciplinary processes that intersect Indigenous knowledge, science, creative practice, and new technology. This work is intended to be presented at public events to actively engage communities in the process and outcomes. The pilot research is now moving to the next phase and the research team intend to expand the project from the focus on cockatoos to exploring the calls of a diversity of wildlife on Kabi Kabi Country on the Sunshine Coast in Australia. The next phase of the project is proposed to focus on aquatic life with the calls of marine mammals and the team are currently exploring Beeyali visualisations with the soundscapes inside trees for Lyndon Davis' first solo exhibition at the USC Art Gallery in Australia.

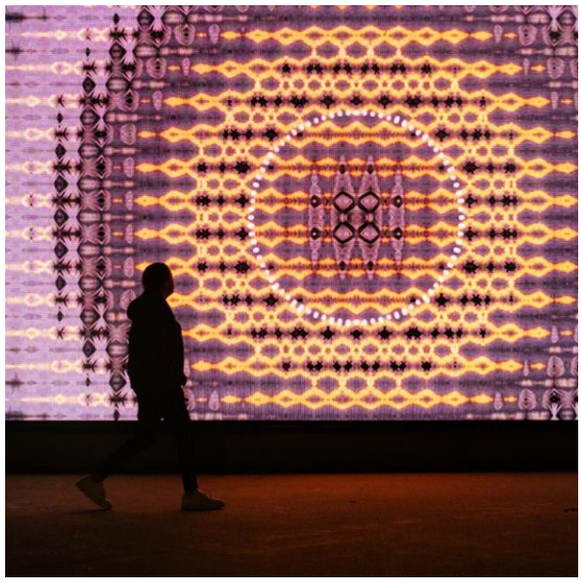

Figure 16: *Beeyali – large-scale projections, NEW LIGHT 2021, Presented by Illuminate Adelaide and ANAT*

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National Flowers in Blue: Reinvigorating analog imaging techniques in the era of big data and pixel perfection

Elke E. Reinhuber
SCM City University of Hong Kong
18 Tat Hong Avenue, Kowloon Tong,
Hong Kong
eer@me.com

The historic cyanotype process is an answer to current challenges of photography. Artists employ an outdated technique to experience the incomprehensible power of the photon and the material qualities of chemical photo-processing. The deficits of immediate availability and inescapable automatisms inherent in the current photographic discourse are answered by recourse to traditional methods of craft. My artistic project for an exhibition on dystopian nature is introduced in the context of the ancient method and its application.

Cyanotype. CCTV. National flower. Photography. Natural History Museum installation. Preservation.

1. INTRODUCTION

The artistic project *National Flowers* combines digital photographs with the historic cyanotype process, depicting the different generations of CCTV cameras of a public transport network.

The starting point for the project was the sensation of constant observation in the tropical city state of Singapore, manifested through the omnipresent surveillance cameras, in particular the flower-like arrangements at each entrance to the mass rapid transit system (MRT). With the systematic capturing of all camera arrays along two of the major rail-network lines, it was essential to elaborate an adequate form for presentation beyond a series of trivial digital images which represent slight variants of the CCTVs. With their flower-like appearance, a specific photographic printing technique which was used for the documentation of plant species nearly two centuries ago proved to be ideal for the project: cyanotype.

2. CYANOTYPE – FROM SCIENCE TO ART

In the current era, in which snapping technical convincing ephemeral photographs digitally became ubiquitous, a tendency can be observed to rediscover historic analogue techniques with all their imperfections and haptic quality. Among them is the cyanotype process, also known as blueprint because of its distinctive Prussian blue hue. For several years now it has been favoured amidst the popular alternative processes, as it is easy to handle, affordable and less toxic than other methods.

***Figure 1**: Arrangement of CCTV cameras along Singapore's MRT line*

First developed by Sir John Herschel in 1842, the cyanotype process was embraced by botanist Anna Atkins, who had been interested in Talbot's process and following its development. Atkins finished her first book on British algae the following year with 194 meticulously arranged plates, including the

botanic title of the species. The shape and translucent structure of the plants was recorded accurately and faster than by drawing. Her books are still on display in renowned institutions such as the Royal Botanic Garden of Edinburgh and the Natural History Museum, London.

For the procedure, potassium ferricyanide and ferric ammonium citrate are diluted with water and mixed; then applied to absorbent paper or fabric and dried. The exposure to ultraviolet light in the range of 365nm on the photosensitive surface causes a photoreaction; when rinsed in water, the image becomes visible while the excess chemicals are washed away and the distinctive blue develops its full intensity during the drying process.

With its origin in scientific imaging, blueprints used to be an essential tool for documentation and duplication, as well for architects and engineers to multiply technical drawings. Herschel's daughter Julia collated cyanotypes to a creative practice and illustrated in 1869 *A handbook for Greek and Roman lace making* (Ware 2016).
Occasionally, cyanotype is confused with the diazo printing process, employed in the 20th century for the above mentioned industrial applications, invented by Father Raphael Kögel OSB from Munich and commercially exploited by the Kalle company of Wiesbaden under the brand name *Ozalid* (USPTO 1929); characteristic is the acrid odour, indicating the other chemicals used.
Although several early images are preserved, it appears that only in recent years, the process found its artistic legitimacy. As Nancy Burns, co-curator of the exhibition *Cyanotypes: Photography's Blue Period* (New York 2016) stated in an interview: "They were so easy they almost didn't count […]. And the fine arts establishment turned its nose on something that was so easy. The fact that they were blue was also just too weird for people" (Voon 2016).

Cyanotype offers a wide range of applications, as evident in the work of the following artists.

Around 1950, the artist couple **Susan Weil** and **Robert Rauschenberg** produced a number of life-sized cyanotypes in the manner of Anna Atkins' 'photogenic drawings' Instead of seaweed, they used their own bodies, tracing their contours and shapes. The large-scale prints were evocatively staged, with the effect of semi-transparent clothes and other carefully draped materials.

Barbara Kasten focuses her images, which often combine multiple techniques, on the layering and folding of materials, in particular wire mesh, to achieve abstract structures. In her project *Amphora* (1996), Kasten worked with the Collection of The Museum of Underwater Archaeology in Bodrum, Turkey. Several ancient amphoras were placed on the light sensitive material. Because of their roundish shape, the proximity to the flat paper varied enormously, as did the shades of hue in the final result, which was reminiscent of their existence under water.

Marco Breuer applies the light-sensitive liquid in drops or patches as chemigrams, brushing the chemicals on the surface of the paper in multiple layers to receive abstract patterns, such as in *Untitled (E-33)* (2005) or deep blue circles in *Spin (E-197)* (2008).

Peter Miller challenged the actual process of the cyanotype by exposing the treated linen to rain and to sun. The result of combining exposure to the sun and rinsing with the rain is a light blue cloth with traces of droplets still visible on closer inspection. He refers to *Rain on a Sunny Day* (2015) as a "self-portrait of rain". For another cyanotype, *Die große Maschine I* (2015), he applied the folding technique for making a paper plane to the sensitised material during exposure, resulting in obvious traces of the folds on the final print.

Rodney Graham's *Mariachi Tie* (2005) calls to mind in its shape a butterfly and is consequently printed as cyanotype next to a black and white image. Different from the previously introduced unique pieces, this print is a reproduction from a negative and exists in an edition of 18.

Noelle Mason applied the blueprint process to X-ray images of human trafficking, which were captured by the *U.S. Customs and Border Protection*. Although the pictures, which reveal eerie hidden immigrants in all kind of vessels, receive additional attention once transferred into an artistic context, it remains questionable if the transfer of the small digital images, found on the internet, to another medium can be considered an independent artistic work and sold on online platforms.

Christian Marclay, in his book *Cyanotypes* (2009), applied the disregarded technique to present the obsolete remains of another medium. The taxonomy of audio cassettes and the unspooled magnetic tape recalls serene images of algae or similar plants, while the mute works suggest in the individual titles some of the performers of the depicted sound recordings. Six series range from images which show the cassettes accurately arranged in a regular fashion, as their numbered title *Large Cassette Grid* indicates, others seem to display organic structures in a chaotic arrangement while further images mix the curly tape with the rectangular cases, as for instance in *Allover (Dixie Chicks, Nat King Cole and Others)*.

***Figure 2**: Two examples of National Flowers, 2021*

3. NATIONAL FLOWERS

For my project, *National Flowers*, I began to digitally collect images of all CCTV arrays along the oldest section of Singapore's main MRT network – the East-West line, as well as a section of the North-South line during less busy weekends and holidays. Besides capturing images which show the installations in their surroundings, each arrangement was captured from underneath its centre with my lens pointing straight upwards. As a reminder of the imaging process behind the multiple observing- and recording-systems, I planned initially to capture the images with an analogue SLR camera; similar to my earlier projects such as *DIN4067*. However, a compact digital camera with a foldable display and manual control (Sony RX100 VII) facilitated the recording of RAW files and enabled the collection of the images to go mainly unnoticed. The impressive amount of cameras, most of which are arranged like flower petals around a centre, resulted in a large database. The folders for each array were named according to the train line, the location, the acronym for the train station and the numbers of the individual cameras. This became also the caption for each print together with the title of the project (e.g. East West line, station number 14, Raffles Place, cameras 285-290: EW14 RFP C285-290).

***Figure 3:** Showcase with Cyanotypes of National Flowers in the exhibition 'Future Memories' 2021*

As the images were all quite similar, with only peculiar differences in their details, I was reminded of the work of a botanist, observing different specimen of the same plant family. Also, since Singapore is proud of her National Flower, the hybrid orchid Miss Vanda Joachim, I observed a similarity to the flower-like camera-arrangements and propose that these might be the true national flowers of the surveillance state.

With these references, it became evident that the technique applied by the legendary botanist Atkins would be well-suited to my project. The transfer from a digital database of surveillance cameras to an early analogue technique invites reflection on the development and presence of imaging technologies, by reclaiming sovereignty over the procedure of image-capturing and processing.

Although all installations were captured from the same angle, similar in size and with identical settings, the surrounding and lighting situation differed hugely. Therefore, all cameras were clipped from the background. The resulting masked images covered a wide range of grey and beige shades. The initial prints were still not sufficiently harmonious to achieve a satisfactory result, which was only achieved through the transfer to cyanotype.

After several experiments in size, density and contrast as well as tests with a positive or negative, the camera arrangements were laser-printed on transparent film including the caption underneath, with the essential information about the 'species', similar to the *British Algae.*

These digital negatives were then exposed as cyanotypes. Initially under sunlight, resulting in a good tonal range and intense blue tone. Since the exposure time was around 10 minutes for each of the 165 images, the unforeseeable weather conditions with wind and rain demanded another solution. Even in Hong Kong, artificial UV light with the specific wavelength of 365nm cannot be easily found in the many lamp shops. Finally, a unit for silk-screen-printing was used, although the light was not as evenly distributed, so that only one print in the size of 5x7" could be exposed at a time. As an advantage, the time could be reduced to 8 minutes with a constant result, unaffected by the changing intensity of the sun. After testing different types of paper and fabric, a finely woven cotton sateen provided the best result. The chemistry could be evenly applied by soaking the cotton in the mixed cyanotype liquid and showed sufficient details with a fine surface. For the presentation, the cloth swatches were mounted on cardboard.

Although one might argue that the images could have been printed digitally in the style of cyanotypes, the tactile process of creating positives with basic ingredients through the exposure to light had almost a therapeutic effect in the current situation where most of our activities happen in front of a screen. Moreover, the artistic value of each image is an individual achievement, in this way unique copies are created one by one, instead of reproductions being spat out at the push of a button. At the exhibition in the Singing Waves Gallery, Hong Kong, in April 2021, a selection – one image for each train station – was presented under the title *National Flowers [Observation]* in four showcases, arranged to evoke a 19th century natural history museum and further reference the cyanotype heritage. A wallpaper with a floral pattern composed of the CCTV cameras completed the installation and tableaus, with information about the taxonomy, distribution, classification and a species inventory placed on the walls.

During this time, another set-up, titled *National Flowers [Reflection]*, employed the same digital footage of the masked camera arrays and was presented as a closed-circuit installation at the "Artmachines: Past/Present" exhibition, in the Indra and Harry Banga Gallery, Hong Kong. The work consists of a CCTV camera at the edge of a mirror-clad triangular prism, observing a display with the images. The kaleidoscopic effect inside the prism turned the cameras into floral ornaments. Users could interact with the display, exploring flowerlike patterns on the projection of the camera's live-stream.

Comparing both exhibitions, the transfer to an analogue medium left a much stronger impression on the audience, in particular by treating the technical equipment like a botanical species. Commenting on National Flowers, the curator of the exhibition Harald Krämer noted their connection to the diminishment of a variety of species in our natural environment. Therefore, we need to find other subjects for research and examination (Krämer 2021).

4. CONSIDERATION

The reassessment of historic photochemical techniques allows the photographer a renewed self-empowerment in her practice, as she is no longer at the mercy of the machines but able to define the result for herself.

Otherwise she would be confined by the power of image processing programmes or photo laboratories' machinations, just as every rider on the public transport system is the object of surveillance cameras' viewpoints and analysis programmes.

As Vilém Flusser writes in *Into the Universe of Technical Images* on page 37: "With the visionary it is quite different: he controls an automatic apparatus that harnesses all this for him so that he can concentrate entirely on the surface to be envisioned. The criteria he applies when he pushes the buttons are thus superficial in both senses of the word: they have nothing to do with the deeper craft of image construction, and they have nothing to do with what goes beyond the surface to be produced."

Figure 4: *Exhibition installation of National Flowers in 'Future Memories. Utopia Dystopia Nature.,' 2021*

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Near-Instant Prototyping of Multi-User Digital-Physical Interactions

Robb Mitchell
University of Southern Denmark
Universitetsparken 1
Kolding DK 6000, Denmark
robb@sdu.dk

1. INTRODUCTION

This is a demonstration of a platform and approach that can enable creatives without any skills in either programming or electronics to almost immediately explore and innovate in combining physical objects, and movement sensing with dynamic visual outputs.

2. MULTI-USER PROTOTYPING IS TOUGH

Designing multi-user digital-physical art or other tangible or embodied interaction experiences to foster or leverage social experiences and collaboration in museums etc. can be challenging. Compared with designing for individual use, prototyping novel multi-user experiences can be more technically difficult regarding both hardware and software, and much more difficult conceptually.

In my previous teaching experience, it is typical for many students to only truly appreciate some of the nuances and complexities of multi-user experiences once they have managed to implement and deployed technical solutions. But this happens normally close to the end of a project when it is too late to make much, if any conceptual improvements.

Compounding these challenges, another difficulty for institutions that are not located in big cities is that many students typically lack direct common experience with a wide range of interactive installations. This can make it much harder for both students and staff alike to build a shared understanding and a common language concerning multi-user digital-physical experiences.

3. OUR APPROACH

To address these challenges, I have been developing an approach that turns upside down some traditional approaches to teaching physical computing. Namely, we have developed software that enables students with no programming or electronic skills to creative experimentation with collaborative digital-physical experiences from the very first hours of our teaching.

3.1 How it Works

In our most recent deployment, the approach comprised providing:

a) Pairs of BBC micro:bit micro-controllers with built-in accelerometers onto which we preload software. An untethered micro:bit wirelessly transmits movement data to the creatives' laptop.

b) Software standalones developed using Max MSP. These enable plug and play manipulation of an image or images of the creative's choosing/making. The accelerometer data thus instantly can control the rotation, size, or position of single images, or control the sequential display of any image folder. Images can be displayed full screen or outputted to a second screen or projector.

c) diverse forms objects of a scale that affords manipulation by two people (e.g. broomstick, tablecloth, large cardboard box) and some simple temporary fixatives (e.g. string, sticky tape etc.).

Users attach their untethered microcontroller to one of the large objects and instantly explore how it is to share control of the image outputs through sharing physical control of the objects. And with a couple of clicks, they can repeat with different images. And of course, not limit their physical explorations to the found objects that we initially provide.

4. ACKNOWLEDGEMENTS

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Rebuilding Ernest Edmonds' Communications Game

Sean Clark
Interact Digital Arts
Leicester, UK
seanc@interactdigitalarts.uk

Sean Carroll
De Montfort University
Leicester, UK
seanzshow@gmail.com

1. INTRODUCTION

In the summer of 1970 Ernest Edmonds and Stroud Cornock had just completed a collaborative project called DATAPACK (Cornock & Edmonds 1973). The interactive computer system was created for the Graphics'70 exhibition at Brunel University and allowed participants to have a "pseudo-English conversation with a computer" (Edmonds & Franco 2013, p.122) with the output being printed out to a drum plotter. While observing DATAPACK, Edmonds began to consider the deeper nature of this interaction and how systems thinking could be further combined with these ideas to facilitate meaningful communication.

2. COMMUNICATION WITHOUT LANGUAGE

In parallel to the technological advances, the 1960s saw great leaps forward in the understanding of developmental cognitive psychology. Cited as a key influence by Edmonds in his research, T.G.R. Bower brought together descriptions of 7 key experiments relating to areas of developmental psychology in his book "Development in Infancy". Bower describes how very young infants seem able to "detect and utilise a contingency between response and reinforcement events" (Bower 1974, p.13). Suggesting that even before language is learnt infants are able to recognise patterns of stimulus and understand their ability to interact and affect them. It is from these considerations of our innate ability to interact with patterns that the first Communications Game was created.

3. COMMUNICATION GAME

Communications Game was first shown as part of Stroud Cornock's "Invention of Problems II" exhibition at Leicester Polytechnic in 1971 (Edmonds 1975). The interface was very simple, each participant was presented with a number of switches and lights. By altering the states of one of the switches, the participant alters the states of two or more of the lights. Some visible to the participant, some to a participant at another station.

Screens kept the participants apart (Figure 1). The stations were not controlled by computer, but rather electric circuits soldered together by Edmonds utilising logic circuits and a truth table to determine the effect of each interaction.

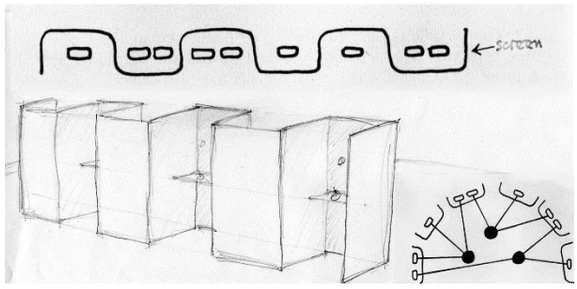

***Figure 1**: Sketches of the Communications Game layout (c. 1971). © Ernest Edmonds.*

The Communications Game was described by Edmonds as a piece of "conceptual art" (Edmonds 2019). He states that it should not be an aesthetic physical object and could be realised in many different manifestations and explains the point as being that the art is "the machine in action" (Edmonds 2019).

The goal of the artwork was not to replicate communication in a way familiar to the audience members but to allow them to explore "low[er] bandwidth" communication (Edmonds 2019). "The responses are such that the participants are likely

to understand each other's actions only partially and even that understanding may be transitory" (Edmonds and Franco 2013, p.124)

While the first version of Communications Game contained six stations. A second, simplified version of the artwork with only 3 stations was created for the Cognition and Control Exhibition at the Midland Group Gallery in Nottingham in 1972 (Edmonds 1972). A much later version of the work was created in 1990 that utilised a LAN network but kept to the 3 station design. The work was shown in the exhibition Art Creating Society at the Museum of Modern Art Oxford (Edmonds 1990).

4. REBUILDING COMMUNICATIONS GAME

In 2015 Ernest Edmonds worked with Sean Clark to create a new version of Communications Game using current technology. The rebuild used Arduino microcontrollers, LEDs and toggle switches (Figure 2) to replicate the functionality of the 3 station original and was housed in a three-sided pyramid that used screens to separate the participants. This was shown as part of Edmond's 2017 exhibition "Constructs, Colours, Codes" in Leicester.

***Figure 2**: The rebuilt Communications Game (c. 2015)*

A new build was started in 2021 with the goal of creating a modular platform on which new variations of Communications Game could be constructed. The current implementation features a small hardware "terminal" (see Figure 3) with switches and LEDs and a WiFi-enabled microcontroller.

The terminals communicate using the MQTT protocol with an Internet-based server that hosts the logic. As buttons are toggled, messages are sent to the server and responses are sent back to illuminate the LEDs. The current configuration of the artwork uses three such terminals and is able to fully replicate the earlier 3 station versions of Communications Game.

***Figure 3**: The new Communication Game terminal.*

Additionally, a web browser version of the terminal has been constructed that also makes use of MQTT communications. The hardware and browser versions of the Communications Game terminal are interoperable, allowing larger networks to be constructed using the Internet for communication between terminals.

5. COMMUNICATION GAME AT EVA LONDON 2022

The first public exhibition of the new build of Communications Game will take place using both hardware terminals and the web at EVA London 2022. Additional information and documentation of the exhibition will be made available on the web at https://www.interactdigitalarts.uk under "Projects".

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The Immortal Shakspeare: Transcribing a micro-calligraphic drawing

Lindsay W. MacDonald
Faculty of Engineering Science
University College London, UK
lindsay.macdonald@ucl.ac.uk

A poster-sized drawing from the 19th Century portrays Shakespeare's monument in Holy Trinity Church, Stratford-upon-Avon. The linework is composed of tiny lettering, less than 1 mm in height, running in a continuous path throughout the design. Direct transcription of the text proved to be difficult. The print was digitised at 1200 dpi and image processing techniques were tried to follow the text lines and recognise the characters, but they were ineffective because of the irregularity of the writing. A software viewer was developed to facilitate navigation of the text on screen, with functions for enlargement, translation and rotation, and for constructing and editing a trajectory line following the path of the text. The text was fully transcribed and three sources were identified from the 1840s.

Shakespeare. Micro-calligraphy. Lithograph. Transcription. Image processing. Viewing software.

1. INTRODUCTION

A curious and very rare print entitled 'The Immortal Shakspeare' was found in the mid-1930s among diverse objects and paintings in a cellar below a former souvenir shop in Stratford-upon-Avon. A scrap merchant was clearing the shop of its fittings, when his truck suddenly fell through the floor into a forgotten cellar, in which were stored all manner of curiosities related to Shakespeare. This had been known as the Shakespearean Depôt, owned by William Pearce, at 6-7 Bridge Street, a prime tourist location in the midst of several large hotels in the town centre. The building later became the Woolworths store (now Poundland).

The print appears to be a lithograph in maroon/sepia ink and has areas of discoloration owing to water damage, with various tears at the edges. At some time in the past, perhaps after it was rescued from the damp cellar, the original has been roughly cut to a size of approximately 380 x 440 mm and glued onto a heavy cream paper of 495 x 553 mm.

At first glance, this is a line drawing of Shakespeare, done in ink with thick lines (Fig. 1). The central design is clearly based on the monument in the chancel in Holy Trinity Church, Stratford-upon-Avon, mounted on the wall above his grave. Closer inspection reveals that the lines are composed of text in tiny letters. But how to read it? Could the text be transcribed from the drawing? What does it say? Who created this remarkable work of art?

2. MICRO-CALLIGRAPHY

Micro-calligraphy, sometimes called micrography, is defined in the OED as the 'art of writing in microscopic characters'. It is also an ancient Jewish art form: 'a word or piece of text in which the design and layout of the letters creates a visual image related to the meaning of the words themselves'. It seems to have arisen from the tension, ever since the time of Moses, between prohibition and usage of images in Judaic religious practice. The second commandment, 'Thou shalt not make unto thee any graven image, or any likeness of any thing …' forbade representations of God as a focus for worship. It was particularly aimed at making idols in the pagan fashion, so prevalent in the ancient world, which infuriated Jahweh in repeated episodes throughout the Old Testament.

Yet artistic expression flourished in Jewish culture. From the ninth century AD onwards Jewish scribes began to form their writing in a decorative way, with the justification that its primary function was text that carried the meaning of the words, and the form it took was merely a way of rendering. It appeared in the miniscule marginal notes in the Hebrew Bible and in little doorpost scrolls. The wording came to be combined with ornamental motifs and geometric designs in borders and title pages. Space-filling techniques with closely-knit lines of text covering large areas enabled textural effects and modulation of the density. Slowly the practice spread from Israel to Egypt and into Europe (Avrin 2013).

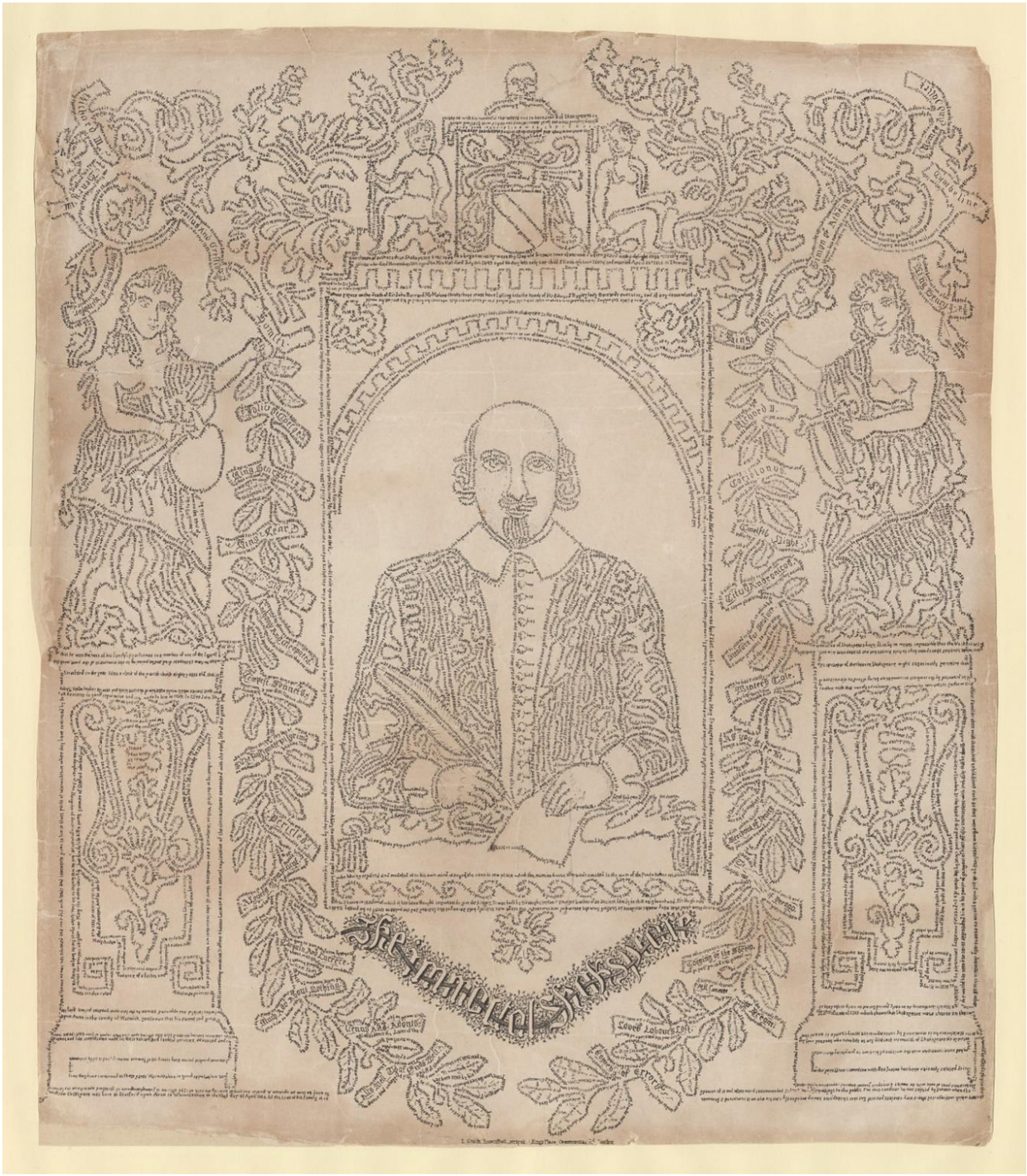

Figure 1: *Print of 'The Immortal Shakspeare'*

By the early 1600s, Italian scribes were decorating marriage contracts with micro-calligraphy, using verses from the Song of Solomon, Psalms and Proverbs, drawing them in geometric and architectural forms, flowers and family crests. In Europe, from the 18th century, micrographic pictures were being drawn on parchment or paper to be hung as decorative art in homes.

Micrographic portraits of royalty also began to appear. By the 19th century popular subjects included Jewish leaders such as Moses and Abraham, biblical scenes, and holy sites in Jerusalem. Micrographers emigrated and established themselves in England, France, Holland, Russia and Poland, and toward the end of the century the art was introduced to America

3. THE ARTIST

A line of text at the bottom edge of the Shakspeare print, revealed when the mount card was removed, gives the identity of the artist:

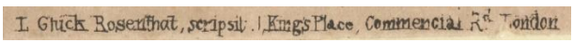

Figure 2: *Detail 50 x 3.6 mm at lower edge of print*

Louis Glück (1804–1874) was born in Prussia. He became fluent in a number of languages, including Hebrew, and styled himself as a 'professor of languages'. He worked for a closer understanding between Jews and Christians and maintained a regular correspondence with many leading figures from both communities. He emigrated in 1836 to Great Britain, took lodgings in the East End of London, and started to make a name for himself as an artist, working in oils, watercolours, and his speciality of micro-calligraphy (Laidlaw 2004). This demanding task brought on considerable eyestrain, for which he was admitted to the London Hospital in 1840. His other known surviving works are micrographic portraits of Queen Victoria (in the Royal Collection, Windsor, and the Victoria & Albert Museum), the Duke of Sussex (British Museum) and John Wesley (in the Wesley Museum at Epworth Old Rectory and the New Room Museum in Bristol).

Figure 3: *Micro-calligraphic portrait of John Wesley*

Glück composed the texts of his royal micrographic portraits after a series of interviews with the prince consort and the duke. He also published them in book form: *Biographical Memoir of Her Most Gracious Majesty Queen Victoria* (1844) and *A Biographical Memoir of his Late Royal Highness, the Duke of Sussex* (1846). For the latter, he used the pen-name 'L. Glück Rosenthal', as it appears on his drawings. For John Wesley (1851) in Fig. 3, he used a well-known portrait painting as the model, and took the text from several biographies (Ryan 2014). Wesley's robe is rendered in closely-spaced lines of text, in the traditional Jewish manner, but the surrounding frame is more decorative in style. The total word count is 13,875 words.

Glück's technique was first to make a faint line drawing of the portrait. He would then write the many thousands of words along the line, adapting the design and weaving the letters together to create a portrait that brought out the character of the subject. Lithography had been invented by Senefelder in 1796 and was at first used to print music. By the 1820s the lithographic technique was widely employed by artists, drawing or writing onto a polished limestone surface in reverse with a wax crayon or a pen using a special greasy ink. This was a difficult task because the artist not only had to work in mirror image, but also had to keep his hands off the surface of the stone to avoid smudging. Glück adopted instead the 'transfer lithograph' method using a specially coated paper to make the drawing, which was then transferred onto a zinc plate. The advantages were that the artist did not have to work in reverse, and when the work had finally been completed it could be transferred to the printing plate by a well-tested method (Gascoigne 2004).

It is likely that many copies of the Shakespeare design were printed, but the only other known copy today is in the collection of the Folger Library in Washington (Folger, 2021). The notes say: 'A likeness of the Stratford bust done in micrography, a style of art where the image is delineated by lines of text, in this case lines from Shakespeare's plays or data concerning his life.' The Folger print gives the artist's address as 3 Prospect Place, New Charlton, Woolwich, whereas the Stratford print has 1 King's Place, Commercial Rd, London (Fig. 2). According to the ODNB, Glück lived at the Woolwich address from 1846 to 1856, then at King's Place until the early 1860s. This suggests that there were two editions of the Shakespeare print.

4. DIGITISATION

The dismounted print was scanned at 1200 dpi on an Epson GT-10000+ flatbed A3 scanner. Because of the large size of the original, the upper and lower halves were scanned separately and then merged in Photoshop, yielding a digital image of 19230x22000 pixels. 1200 dots per inch is equivalent to sampling the surface at 47 points per mm, so the pixel spacing is 21 μm. This is sufficient to resolve the finest detail that can be rendered by

human hand (MacDonald 2010). The very high spatial resolution gives clear definition of the micrographic text, as shown in Fig. 4, a detail from Shakespeare's right eye, of size 400x400 pixels. The diameter of the letter 'o' ranges from 30 to 40 pixels, i.e. 0.64 to 0.85 mm. The overall height of the characters, from the bottom of the descenders to the top of the ascenders, ranges from 90 to 120 pixels, i.e. 1.9 to 2.5 mm. This corresponds to type sizes of approximately 5 to 7 points.

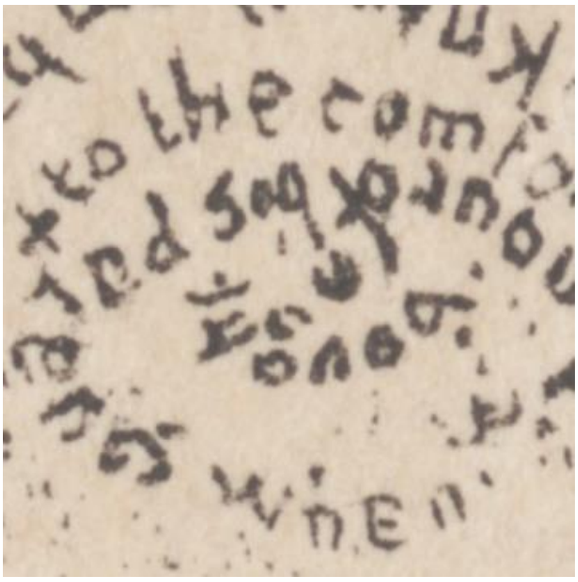

Figure 4: *Magnified detail, 8.5 x 8.5 mm*

The source of the text was not clear at the outset of the study: whether it was something original, written by Louis Glück himself, or whether it was copied from another work. The objectives of the investigation were therefore to transcribe the text by following the sinuous lines and then, if possible, to identify the source(s). It quickly became apparent, however, that the transcribing could not easily be done by direct reading from the original print. Of course the original is too fragile for repeated handling, so a printed facsimile would have to be used. In addition the print area is larger than A2 and therefore takes some effort to manipulate physically in order to get close enough to see every word. Moreover, the lettering is very small and near the threshold of visual acuity, necessitating bright illumination and/or the use of a magnifying glass.

Most frustratingly, the line of text winds endlessly around, sometimes in spirals, sometimes doubling back on itself in serpentine fashion, sometimes crossing over its path, so that one continually has to turn the printed sheet to orientate the text for normal reading. Because of the complexity of the design, it is easy to 'lose the place' when attention is diverted, for example when looking away to write or type on a keyboard (although this might be alleviated by use of a voice recorder). To make matters worse, the lettering is not uniform but changes in size and slope from letter to letter, and in some places is distorted or faded. It took six months to transcribe Glück's drawing of John Wesley, working from a photostat copy (Onstott 1935). None of this is surprising, considering the extreme difficulty that Glück himself must have experienced when writing the original. It is extraordinary that he was able to do it at all!

5. APPLICATION OF IMAGE PROCESSING

Suppose that image processing techniques could be employed to follow the curvature of the lines of text? In an ideal scenario, one could automatically locate the trajectory and then unfold or unwind it into a linear text line that would be easier to transcribe. Better still, perhaps character recognition could then be applied to the linear text, by training an algorithm on the written letter forms?

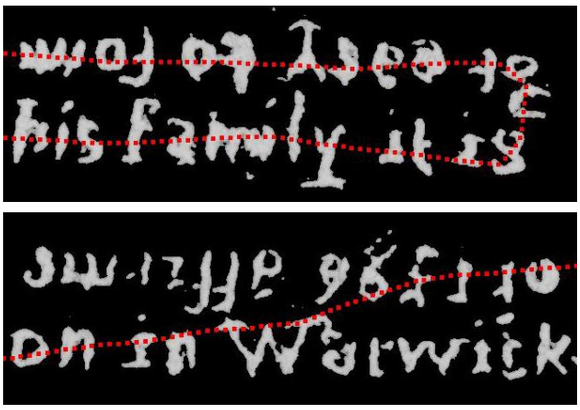

Figure 5: *Two sections of automatically-generated text trajectory: (above) correct; (below) incorrect*

The approach tried was to search along the digital text trajectory, looking ahead to determine the most likely direction of travel. Different vector lengths and angular weighting factors were tried, but invariably there were places where the wrong track was followed, even for simple cases (Fig. 5). In other cases such as Fig. 6 (left) the text path is very convoluted, and it is not at all obvious where the correct trajectory should go.

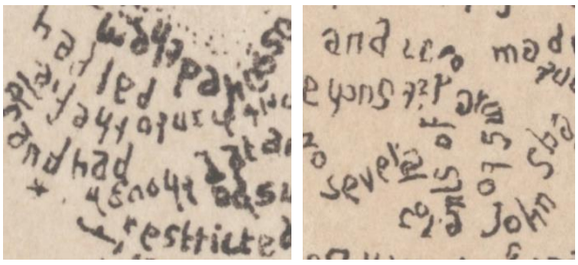

Figure 6: *Details of (left) Shakespeare's moustache and lips; (right) foliage in garland*

Another example is shown in Fig. 6 (right), where the text reads ‘several grants of arms to’ but after each word the connectivity is unclear. Only an iterative semantic method would be successful, in which meaning would guide the identification of letters and words and the connections between them.

In some places there are insertions of decorative features, which look like text but are not part of the narrative. For example, in Fig. 7 (left) are shown two of the buttons, saying ‘1564 born’ and ‘1616 died’. These alternate all the way down Shakespeare’s waistcoat, but have no association with the vertical lines of text on each side. Likewise the names of all 36 plays appear in large letters in the garlands down either side (Fig. 7 right) but have no connection with the surrounding text lines. The name ‘William Shakspeare’ is also used as the central midrib of each leaf in the garlands, sometimes with numerical dates for the side veins.

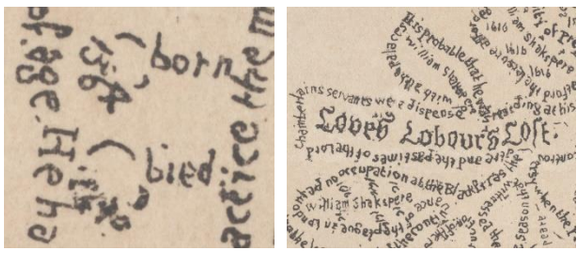

Figure 7: *Details of (left) buttons on waistcoat; (right) name of play within garland*

Irregularity in the letter forms would make the task of automated optical character recognition (OCR) more difficult. For example, in Fig. 8 (left) the word ‘held’ has the ‘d’ written in reverse. In Fig. 8 (right) the word ‘friends’ has the ‘s’ reversed and the ‘e’ is an odd shape and the ‘n’ is missing.

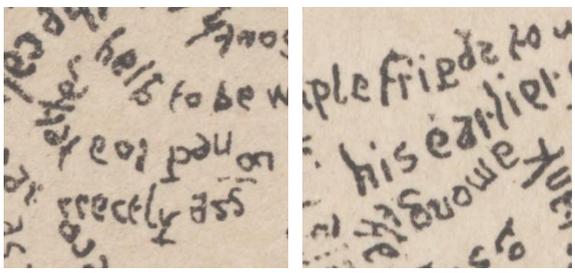

Figure 8: *(left) letter reversal; (right) mis-spelling.*

The problems are similar in some ways to those of transcribing manuscripts written in Elizabethan ‘secretary hand’. Ambiguities in letter forms can only be resolved through recognition of whole words and phrases, and it takes time to become familiar with the style and conventions of the writer. It would have been easy to waste a great deal of effort trying to develop a sophisticated algorithm to adapt to every aspect of the changeable line of text, overcoming areas of uncertainty and avoiding false paths.

6. INTERACTIVE IMAGE VIEWER

The purpose of this study was not to produce a generalised tool for transcribing all micrographic drawings, just to facilitate the transcription of this particular drawing. An alternative to reading from the physical print is to view the digital image using standard software such as Adobe Photoshop. But it is still not at all easy, because of the need to rotate the view very frequently, and the very large image size slows down the processing speed – the full image in 24-bit RGB format occupies 649 Mbyte. Segmenting it into more convenient smaller pieces leads to problems at the edges when the text crosses from one piece to another.

The Folger Library provides an online viewer for images in their LUNA library, with facilities for zooming and rotation by increments of 90°. The magnified image may be dragged around by holding down the mouse button, and moved left-right and up-down by use of the arrow keys. There is a navigation window to show where the magnified section lies in the overall image. Annotation tools are available to draw lines or shapes, together with explanatory text, in a separate layer. An attempt to use this viewer to read the text, however, revealed that it was not ideal, with some of the same problems as for reading a physical print: rotational increments not fine enough, easy to lose the current position, and difficult to relate the text stream to the image coordinates. The opinion of the Folger librarian, Abbie Weinberg, was that the task of transcribing the whole work would be “moderately Herculean”.

Hence a software viewer was developed in Matlab for displaying a section of the drawing. The complete high-resolution image is held in a memory buffer, and a selected area rendered in a window approximately half the width of the HD display screen. This leaves space on the screen for a second window running a text editor (Microsoft Word) for typing the transcription.

Two organising principles were adopted to impose some structure on the text and its spatial layout. First, the text was chunked into numbered paragraphs of length 80-100 words. Second, the trajectory for each paragraph was recorded as an ordered list of up to 120 coordinate pairs.

The viewer has four different modes of operation:

(1) Viewing of the print, using keyboard characters for convenient zooming, rotation and movement. The compete image is held in a memory buffer and the rectangular display window mapped onto it by the standard trigonometric transformation:

$$\begin{bmatrix} x_d \\ y_d \end{bmatrix} = \begin{bmatrix} x_c \\ y_c \end{bmatrix} + m \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x_i \\ y_i \end{bmatrix} \qquad (1)$$

where:

$[x_d, y_d]$ are the target coordinates in the full image (rounded to the nearest pixel);

$[x_c, y_c]$ are the image pixel coordinates of the current centre of view;

$[x_i, y_i]$ are address coordinates spanning area of display window $[-w/2 + 0.5 : +w/2 - 0.5]$;

m is the magnification factor (<1 to reduce, >1 to enlarge);

θ is the rotation angle (degrees).

Image manipulation commands enable change of θ to rotate the image by increments of ±15°, ±90° and 180°; change of m by factors of $\sqrt{2}$; and step change of $[x_c, y_c]$ for translation up/down or left/right. The computation of Eq. 1 is applied to every pixel in the display window each time the display is refreshed.

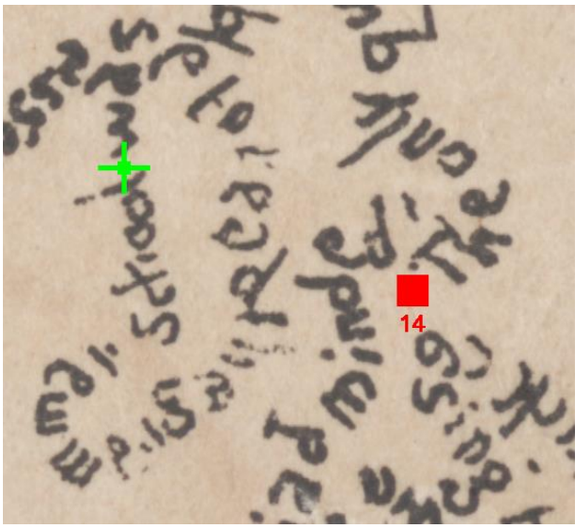

Figure 9: *Section of viewer screen showing marker (red) and focal (green) points*

(2) Construction of the trajectory. A numbered red marker point is placed at the start of trajectory for each paragraph by a click of the left mouse button. Successive segment points along the trajectory are entered by the right mouse button. Commands enable moving back and forth between paragraphs to bring any numbered point to the centre of view. A focal point, denoted by a green cross, may be placed anywhere as an aid to navigation (Fig. 9).

(3) Editing mode enables individual segment points within the trajectory of one paragraph to be added, moved or deleted. The segment lines may optionally be displayed as a transparent blue overlay (Fig. 10).

(4) Visualisation of the full print area, scaled to fill the display window height, showing in blue overlay the trajectory of one or more paragraphs. A coarse 7x9 grid is also defined over the print area, shown by overlay of green lines, with horizontal coordinate (column) A–G and vertical coordinate (row) 1–9.

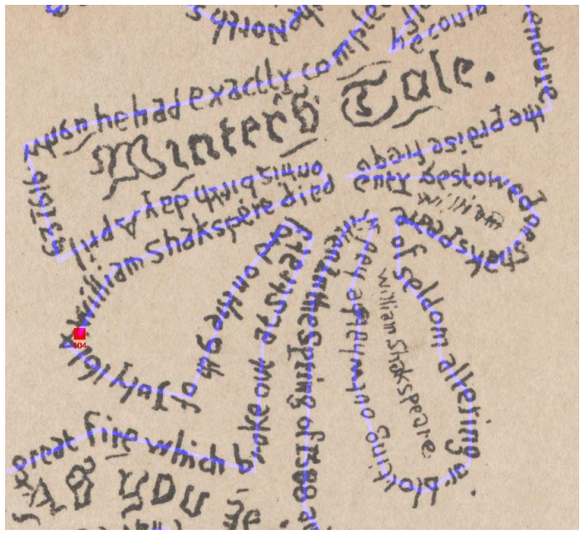

Figure 10: *Section of viewer screen showing trajectory segments overlaid on the text in blue*

7. SOURCE OF THE TEXT

The purpose-made software viewer facilitated the complete transcription of the text. Altogether 104 paragraphs were produced, with a total of approximately 7,700 segments (an average of 73 segments per paragraph). The total number of words, excluding the names of the 36 plays, is just under 8,900 (an average of 85 words per paragraph). The starting point of the text is at the bottom left, indicated by a pointing finger, and the trajectory goes up the pillar and muse on the left side, down and back up the left garland, across the top, down the muse and pillar on the right, around the lower part of the right garland, all around the central figure of Shakespeare and finally up the remaining portion of the right garland, finishing just above Richard II (beside the muse's lyre).

Once the text had been transcribed, it was possible to search through online archival reference files, particularly in archive.org and Google books, to find a match on phrases with distinctive wording. Three sources were identified, primarily the section 'Life and Writings of Shakspere' in the Introductory Volume of *The Pictorial Shakspere* by Charles Knight, published in 1846. This was a condensed version of Knight's book *William Shakspere: A Biography*, first published in 1839 and repeated in numerous editions throughout the 19th century, and also used as a source of text. A third source was the section 'Sketch of the Life of Shakspeare' in Volume 1 of *The Plays of William Shakspeare*, ed. George Steevens and Alexander Chalmers (1805).

Knight's series of publications contributed enormously to the growing market in the 1800s for Shakespeare's works, which was inextricably linked

to the ever-expanding Victorian cult of 'bardolatry' (Young 2009). Knight's biography was the 'standard life' of Shakespeare, and was a point of reference for many authors during the period that Glück was active. Of the 104 paragraphs in the transcription, 88 were from Knight's *Pictorial Shakspeare*, 15 were from Steevens, and 1 was from Knight's biography. All of these were copied verbatim from the sources, without paraphrasis, albeit with numerous spelling errors, missing words, and absence of most of the punctuation.

The artist added nothing of his own except the final sentence: 'Thole of this design was executed and written during a period of six days by Louis Glück Rosenthal on the first of June 1849, in the forty seventh year of his age'. This seems to have been a missed opportunity: as a humanitarian and man of letters, he could have expressed his own opinions on the values and creative ideas of Shakespeare, leaving a kind of time capsule for posterity, embedded within the calligraphy.

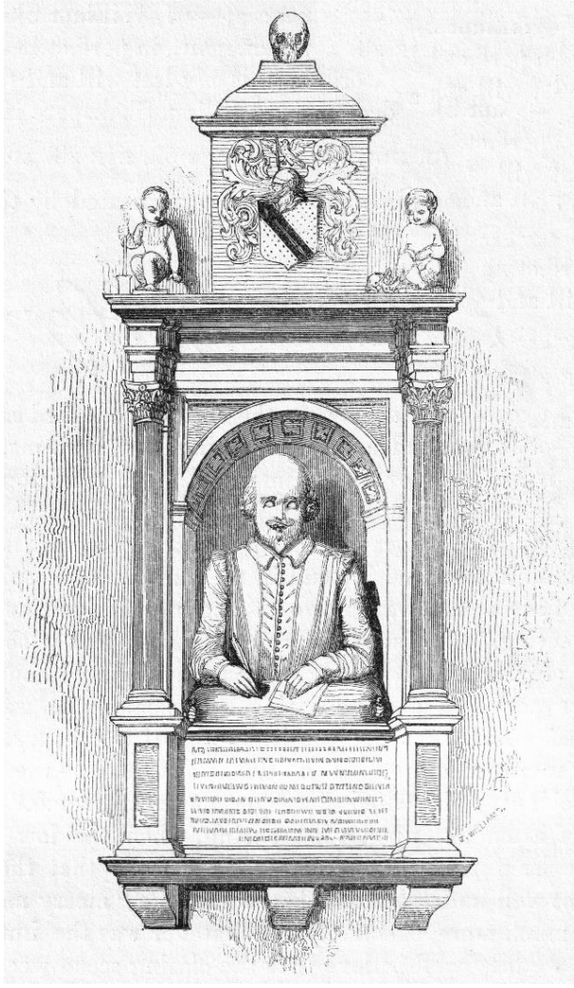

Figure 11: *Engraving of the Shakespeare monument, in Knight's biography (1843 edition, p.532)*

Knight's book contains an engraving of the Shakespeare monument in Holy Trinity, shown in Fig. 11. Comparison with Fig. 1 indicates that Glück followed the design closely, apart from compression of the crest and skull at the top, and added on each side luxuriant garlands with a playful muse on a pedestal. It was a common convention in the 18th century to depict the Greek muses of Comedy (Thalia) and Tragedy (Melpomene) on either side of a person associated with dramatic art, usually with comedy on the left and tragedy on the right. For example, in a celebrated painting of 1761, Joshua Reynolds showed the actor David Garrick caught between the muses, hesitating as if uncertain which way to turn. A delightful engraving of 1778 by Chodowiecki shows the two muses attending to Shakespeare's coiffure and laurel wreath (Fig. 12).

Glück may have also been influenced by the muses on the magnificent marble sculpture by Thomas Banks, officially known as 'Shakespeare seated between the Dramatic Muse and the Genius of Painting', which at that time stood over the entrance to the British Institution in Pall Mall, formerly John Boydell's Shakespeare Art Gallery from 1789 to 1805. The sculpture was removed to Stratford-upon-Avon in 1871, and is now installed at the far end of the Great Garden behind New Place.

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The transcription and supporting files have been archived at: DOI: 10.13140/RG.2.2.33748.68485

Figure 12: *Engraving of Shakespeare's bust on a plinth, attended by the muses of comedy and tragedy, by Daniel Nikolaus Chodowiecki (Berlin, 1778)*

9. APPENDIX

The print is in the possession of Mr Tony Bird of Billesley, Warwickshire. Some passages from the transcription are given below, to convey a flavour of the text. The style of Knight in the passages selected by Glück is meandering and adulatory. Note that Knight always spelled the poet's name as 'Shakspere', whereas other authors tended to 'Shakspeare'. The numbers of the passages below are the paragraphs extracted in transcription.

The family ancestry (Knight):

[1] William Shakspere was born at Stratford upon Avon in Warwickshire on the 23rd day of April 1564. Of the rank of his family it is not easy to form an opinion. A public document bearing the date of 1596 affirms of John Shakspere of Stratford upon Avon the father of William Shakspere that his parent and late antecessors were for their valiant and faithful services, advanced and rewarded of the most prudent prince king Henry VII of famous memory, and it adds sithence which time they have continued at these parts of Warwickshire in good reputation and credit.

Commercial nous (Knight, quoting Rowe):

[57-59] … in the time of Elizabeth, coaches being yet uncommon and hired coaches not at all in use, those who were too proud, too tender, or too idle to walk went on horseback to any distant business or diversion. Many came on horseback to the play and when Shakspeare fled to London from the terror of a criminal prosecution, his first expedient was to wait at the door of the playhouse and hold the horses of those that had no servants that they might be ready again after the performance. In this office he became so conspicuous for his care and readiness that in a short time every man as he alighted called for Will Shakspeare and scarcely any other waiter was trusted with a horse while Will Shakspeare could be had. This was the first dawn of better fortune. Shakspeare finding more horses put into his hand than he could hold, hired boys to wait under his inspection who, when Will Shakspeare was summoned, were immediately to present themselves as "I am Shakspeare's boy, Sir". In time Shakspeare found hire employment but as long as the practice of riding to the playhouse continued the waiters that held the horses retained the appellation of Shakspeare's boys.

Dalliance with the Davenants (Steevens):

[77-78] If tradition may be trusted, Shakspeare often baited at the Crown Inn or tavern in Oxford in his journey to and from London. The landlady was a woman of great beauty and sprightly wit, and her husband Mr John Davenant, afterwards mayor of that city, a grave melancholy man, who as well as his wife used much to delight in Shakspeare's pleasant company. Their son, young Will Davenant, was then a little schoolboy in the town of about seven or eight years old, and so fond also of Shakespeare that whenever he heard of his arrival he would fly from school to see him. One day an old townsman observing the boy running homeward, almost out of breath, asked him whither he was posting in that heat and hurry. He answered to see his Godfather Shakspeare. There's a good boy, said the other, but have a care that you don't take God's name in vain.

The incomparable genius (Knight):

[88-90] These productions afford the most abundant evidence that the greatest of intellects was in the most fearful possession of its powers. The influence of time in the formation and direction of the poetical power must yet be taken into account as well as a temper arising out of passing events. Shakspere was now thirty seven years of age. He had attained to the consciousness of his own intellectual strength, and he had acquired by long practice the mastery of his own genius. He had learnt to direct the stage to a higher and more noble purpose than those of mere amusement. It might be carried farther into the teaching of the highest philosophy through the medium of the grandest poetry. The Epoch which produced Othello, Lear, Macbeth has been described as exhibiting the genius of Shakspere in full possession and habitual exercise of power as its very point of culmination.

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NFTs In Music Industry: Potentiality and Challenge

Raffaella Folgieri
Department of Philosophy,
Università degli Studi di Milano
Via Festa del Perdono, 7, Milan, Italy
Raffaella.Folgieri@unimi.it

Paul Arnold
Bob and Barn Ltd
124 Malvern Road
Cambridge, CB1 9LH, UK
bob@bobandbarn.com

Alessandro Giuseppe Buda
Department of Philosophy,
Università degli Studi di Milano Via
Festa del Perdono, 7, Milan, Italy
Alessandrogiuseppe.buda@studenti.unimi.it

1. INTRODUCTION

The market for composers of music for film, TV or videogames is more complex and competitive than that of pop music. Revenues are lower and it is more difficult to achieve a stable and recognised position.

Since the 1990s, music and technology have been closely intertwined, and the composer community pays great attention to new ways of expression and innovative means of distribution. Unfortunately, the initial promises of democratization of the music business have been largely unfulfilled, due to the legal or commercial failure of bottom-up projects such as Napster or MySpace.

This short paper aims to address opportunities, challenges and possible drawbacks about the adoption of non-fungible tokens (NFTs) in the music composition market, exploring possible sustainable business models.

2. THE CONTEXT

Music composers' natural engagement is through publishers, serving as administrators of a composition. Their services usually include managing writers' catalogues, placing and promoting the composition, etc. (Kretschmer et al.1999). Usually, royalty distribution schemes are regulated so that the income is split between the author and the publisher, whose role consists of helping artists to develop their market and achieve a stable reputation (Bennett 2008).

Moreover, another source of income for film and TV composers is represented by libraries (Minibayeva & Dunn 2002). A music library consists of music-related materials for patron use, working as an agent allowing composers to realise income on licensing fees or as co-publisher, offering the author a 50/50 income split, lower than a traditional co-publishing deal. Music libraries, however, provide an alternative revenue stream especially for composers of film music, TV, documentaries, and videogames.

2.1 Non-fungible tokens

Contemporary digitization is also applicable to music composition and the arise of new distribution media (Scherer 2006) facilitates composers to enlarge their possible audience through social media channels, such as Patreon (https://www.patreon.com) and Twitch (https://www.twitch.tv/), giving them the opportunity to develop their own fanbase and potentially earn more, increasing their visibility and social media reputation.

In this scenario, *Non-fungible tokens* (NFTs) technically enable composers to develop a new market, mainly targeted at direct users, amateurs, fans, a larger number of publishers, ensuring through the blockchain the possibility to verify authorship, authenticity, rights and associated royalties and their duration (Regner 2019; Wang 2021; Chevet 2018). NFTs, also known as digital contracts or, according to Ethereum naming convention, as *smart contracts,* are blockchain-based digital signatures used to authenticate digital assets. The simplest approach consists in transferring the ownership of the composition via NFT and keep the royalties as the author.

NFTs associated to a limited collection of music, for example, represent the opportunity for a fan to participate in the career of their favourite artists, supporting their work, the development of their reputation and earning from them.

Given how NFTs work, it is necessary to determine how to place it on the market. NFTs are mainly

linked to Ethereum Blockchain and placing an NFT on any marketplace, e.g., Opensea (https://opensea.io/) necessitates the ownership of an Ethereum Wallet, such as Coinbase (https://www.coinbase.com/) or Metamask (https://metamask.io/) and entails an initial fee that can be high, depending on demand, and therefore on the moment in which the operation is made. An initial assessment must therefore be made on the value attached to the NFT and inexperienced creators run the risk of losing their money in the process of selling their art.

Several options are available on the market, based on currencies other than Ether (ETH), e.g., Binance NFT Marketplace (BNB currency), Solana (Sol currency), and even non-crypto alternatives such as Coinbase. A GAS-free alternative is represented by Polygon Network (MATIC currency), an Ethereum-based platform that enables blockchain networks to connect and scale. The choice of platform affects both the trading currency of the digital asset, and the way in which such assets can be traded. As an example, minting an NFT on Polygon blockchain allows the creation of more than one edition of the same file, but it can't be auctioned, whereas using the Ethereum blockchain, it can, but not with multiple editions. Opensea, the main NFTs marketplace, allows its users to sell their assets in several currencies, on both Ethereum and Polygon blockchains, facilitating multi-platform trading.

Once the NFT is sold, the new owner may decide to resell it (at a fixed price or auctioned) and may also receive offers from other users. The original owner, retaining the copyright of the original file, may decide to mint more than one NFT using the same art piece, i.e., the same file, at the risk of devaluing his own art.

A case study worth mentioning as an example is ClownCore. They are a duo (saxophone and percussion) who play in disguise to conceal their identity. They launched an industrial project and minted their latest 4 songs as an NFT collection on Opensea (https://opensea.io/collection/clowncoin). These tracks were sold for a total of ETH 2.1922 (€ 6179.98 at today's exchange rate). Interestingly, their fanbase is very limited (only 180000 subscriptions on YouTube). Despite this, clowncoin3, which is the only NFT for sale is currently out at ETH 3.124 ($ 10082.49 - € 8806.79)

The described case study shows some potential in using NFTs to enlarge authors' audience and market. Moreover, several business model could be designed to allow composers and musicians to get the most from their art.

At the time of writing, we are also about to conduct an experiment to assess the convenience of this simple business model. The NFT will be offered as a one-off – thus as a collector's item – to fans of the composers involved in the experiment (Bob and Barn). We aim to present the result (opportunities and possible drawbacks) in a further paper.

NFTs have also been criticized for their impact on the environment due to the energy consumption associated to the *minting* process and to the blockchain-based trading operations (Chohan and Paschen 2021). Moreover, despite its critics, NFTs appear an attractive opportunity especially in the current market sufferance due to the lack of income because of Covid-19 restrictions.

3. ACKNOWLEDGEMENTS

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Mediation in the Post-Internet Condition

Elisavet Christou
Lancaster University
The LICA Building, LA1 4YD, Lancaster, UK
e.christou@lancaster.ac.uk

This paper examines the dimension of mediation in the post-Internet condition through the post-Internet art medium. In the post-Internet condition, human and non-human actors, humans and machines, networks, algorithms and technologies, co-create conditions of life in a hybrid and liquid state of mediation. The paper discusses three important areas of mediatisation as highlights and indicators of the hybrid and multifaceted character of mediation post-Internet. These are mediated publicness, mediated self and mediated trust. The artworks discussed in this paper help illuminate the dynamics, tensions and experiences of contemporary mediation and act as examples of how important the role of mediation is in our understanding of the world and of ourselves in it and how vital it is to continue to explore and critically engage with its processes.

Mediation. Mediated publicness. Mediated self. Mediated trust. Post-Internet art. Post-Internet condition.

1. INTRODUCTION

The cultural transformations that have taken place since the popularisation of the Internet and the World Wide Web (WWW) in the mid 90s are numerous and deal with issues relating to the technological, social, economic, ethical, political, environmental and aesthetic domains. These transformations are often happening at the intersections of individuals and organisational structures, where for example, the roles of users and producers have become increasingly difficult to differentiate, or the role of cultural institutions and art in general has been constantly challenged and re-considered. At the same time, cultural spaces and practices – how and where culture takes place/being produced/being formed – have changed dramatically. All the above are the direct result of a world changed by Information and Communication Technologies (ICTs) along with significant events and changes in the economic and political spheres of geographies around the world. The results of this transformation are full of complexity and contradiction. By being a cultural product of life with and after the Internet, Internet art (from net.art to post-Internet art) symbolises the drastic changes that took place on and to the Internet. Post-Internet refers to the new processes and conceptual dialogues that arose due to these social changes. It is a critical shift from discussing the Internet as a contained entity governing merely our digital interactions to saying something more about its ubiquitous presence and the reconfiguration of all culture by the Internet (Connor 2013).

This paper aims to examine the dimension of mediation in the post-Internet condition through the post-Internet art medium, in an effort to produce a better understanding around the changing nature of life post Internet and very importantly, to encourage researchers at the intersections of sociotechnical and technocultural research, to consider the ubiquitous medium of Internet art as a rich and useful tool for their work. In the Posthuman Glossary, Clark writes about the post-Internet:

> This rebirth of a condition defines a quantitative shift in the ontological treatment of digital-non-digital technological hybrids on both sides of the posthuman ambivalence. This includes interleaving with, and de-centring, difference through connections to previously out of reach global otherness on the one hand, and the use and reproduction of dominant, standardised distribution, production platforms and protocols which redefine much of the space formerly known as offline, on the other (Clark 2018).

The concept of a 'condition' aims to create an understanding of exploring the historical present and to provide a framework for exploring its elements which in the case of this paper is the dimension of mediation. The main point of mediation in the post-Internet condition has to do with viewing the mediated experience on the same level as primary experience. Mediation in the post-

Internet condition moves further than the digital cultural heritage (Zschocke et al. 2004), or the physical as digital through digital reproduction processes (Manovich 2001). In the post-Internet condition, the shift from analogue to digital is not a point of friction anymore while mediation through digital technologies does not rely on reality representation but rather on acceptance of mediated realities as reality. Post-Internet mediatisation processes bring together the physical, imagined, virtual and the hybrid (Manovich 2013). Viewing the mediated experience on the same level as primary experience has been associated with the work of many post-Internet artists like Parker Ito, Oliver Laric and Artie Vierkant (Quaranta 2015).

Mediation post-Internet is shaped by participatory cultures within network societies (Castells 2004; Castells 2012), where socio-cultural processes operate within an overabundance of information and contribute towards a constant process of creation, distribution, usage, manipulation and integration of information in all its forms. Mediation in the post-Internet context can be understood as a complex and hybrid process of "understanding and articulating our being in, and becoming with, the technological world, our emergence and ways of intra-acting with it, as well as the acts and processes of temporarily stabilising the world into media, agents, relations, and networks" (Kember & Zylinska 2012). A key concept discussed by Kember and Zylinska is that mediation entails recognising our locatedness within media as being always already mediated. This allows for a meta-level of mediation where engagement with the world happens within conditions of mediation that can be measurable and identifiable, but they can also be un-measurable and non-identifiable. The un-measurable and non-identifiable aspects of mediation in the post-Internet condition, hint towards the unprecedented, unexpected, unformed and unruled products of mediation where the networks and infrastructures of ICTs exist together with an infinite production of both human and non-human-produced knowledge, communication, experience, politics and culture. Human and non-human actors, humans and machines, networks, algorithms and technologies, co-create conditions of life in a hybrid and liquid state. In this mediated state, the human and non-human exist in a state of mutualistic symbiotic intra-action, meaning that human and non-human actors are attached by constantly exchanging and diffracting, influencing and working inseparably (Barad 2007).

To examine and understand this level of mediated life post-Internet requires a view of the Internet as more than its technical elements, systems, protocols and networks. The various processes of mediation that involve ICTs have definitely a lot to do with their technical elements, however, their biological elements are equally important in producing and driving these processes of mediation. Together, the biological and the technical elements are capable of generating new forms, unprecedented connections and unexpected events within what Zylinska calls 'living media' and 'biomediations' (Zylinska 2020). This shift from ideas of connected media and media life that examine a metaphysical 'living' condition as a result of the connectivity of the object to the world via the medium, to a living condition that both exists within and drives the mediatisation processes is a key element of how mediation in the post-Internet condition could be approached and understood. Mediation post-Internet can even be described as multidimensional and post-Internet artworks can be understood as art in the post-Internet condition instead of technologically-mediated art.

Any aspect of sociocultural production affected by the Internet can be considered as mediated based on its mediatisation processes, like mediated sociality, mediated entertainment and mediated consumerism. Three main areas of mediatisation are being discussed here as highlights and indicators of the hybrid and multifaceted character of mediation in the post-Internet condition. These are mediated publicness, mediated self and mediated trust.

2. MEDIATED PUBLICNESS

Publicness is one of the aspects of life that has been discussed in the last two decades as an increasingly mediated process. More specifically the mediation of publicness is linked to the rise of social media and how public engagement has been shaped by ICTs. The link between publicness and technologies has been extensively examined from the lens of the public and the media. Communities have always used media like newspapers, radio and television to create new publics, and form new connections amongst actors/users and the public (Dayan 2001; Harrison & Barthel 2009). To the extent they could, people have always used media to create public identities for themselves, others, and groups (Baym & Boyd 2012). The scale, pervasiveness, ubiquitousness and connectivity of the Internet and more specifically of social media, are what makes the level of widespread publicness post-Internet unprecedented. This increased level of mediated publicness depends on practices of appropriation of both Internet technology and web content within the context of participatory cultures (Christou & Hazas 2017).

The socio-cultural practices of mediated publicness are dependent on the appropriation of networked media tools, ICTs and web content. Smartphones,

cameras, editing applications and software are what people use to take photos and videos to document their lives or to simply create content for Instagram, Facebook, Twitter and YouTube. Social media are where people can post their content, engage with the public, consume content and participate in online social interactions. Platforms for social news aggregation and discussion and chat software like Reddit, Discord and Twitch, are where people can engage with specialised topics and form niche yet global communities. Countless sites dedicated to online news and content aggregation like Digg, Pocket and Fark, are where curation of the massive everyday social activity online along with community engagement and participation based on interests and topics takes place. All of the above and much more, enable activity by mediated connection to take place as part of a new form of mediated publicness.

Internet artists have been using these mediated public spaces to directly connect with global audiences without necessarily targeting art audiences. Online performances through social media are a great example of how an art experience can be designed for mediated public spaces. Amalia Ulman's scripted performances designed entirely for circulation in Instagram and Facebook: *Excellences and Perfections* (2014), and *Privilege* (2016), are notable examples of this practice. Both works are premised on appropriating and acting out the expectations of the social media audience by "...turning a mirror back onto the fantasies of this public in order to expose their effects on how women perceive themselves" (Smith 2017). The performative nature of both Facebook and Instagram platforms, where identities and experiences are carefully constructed and curated for public consumption and approval (like, share and comment functions), guide the nature of these online performances where artificial situations are presented as real. These situations include plastic surgery and fake locations (staged photos) like cities and hotel rooms.

The *Red Lines* artwork (Figure 1) by Evan Roth is a peer-to-peer network performance. The *Red Lines* network connected users with servers in geographically specific locations to participate in the sharing and viewing of 82 individual pieces from the artist's *Landscape* video series. Over the course of two years (2018–2020), 120,000 people in 166 countries connected to the *Red Lines* network. The work was commissioned via the arts organisation Artangel's open call for proposals to produce a major project that could be experienced anywhere in the world. The artist has travelled to coastal sites around the world where Internet cables emerge from the sea to record the work's videos (artangel.org). Red Lines investigates the physicality of the Internet through a public performance that any viewer could stream at home but also become an active participant to the work's network. This is because of the Red Lines's decentralised peer-to-peer network where a viewer becomes part of the network, streaming from other viewers who simultaneously stream the feed from them, anywhere in the world.

> *Red Lines* is a network containing infrared videos of coastal landscapes that can be streamed to a smartphone, tablet, or computer by anyone, anywhere. By setting a device in your home or workplace to display this artwork, you share a synchronized viewing experience with people around the world. Filmed in infrared, the spectrum by which data is transmitted through fiber optic cables, 82 slowly moving videos are stored on servers located in the same territories in which they were filmed. When you view a network located video made in Hong Kong, for example, it activates the submarine cable route between Hong Kong and you. You then become part of the peer-to-peer network which enables this work to be experienced by people around you (Roth 2020).

***Figure 1**: Red Lines, Evan Roth, 2018-2020. Available at: https://www.artangel.org.uk/project/red-lines/*

3. MEDIATED SELF

The reality of the mediated self – a concept that is not new or born through the mediated processes of ICTs and digital media – becomes extended in the post-Internet condition. As with appropriation or mediated publicness, the mediated self, moves further than the virtual image-body represented as a proxy or a stand-in for a 'virtual' world. The self in a state of mediation is what becomes the state of the self, post-Internet. Earlier technologically mediated representations of the self like mirrors, photographs and videos have allowed for new understandings of how the self can be seen by ourselves or others, in different representational mediums and different times and spaces. The number of interactions that ourselves can have online along with the abundance of spacetimes within which ourselves exists online, and the ability

to willingly or unwillingly control/archive/trace/manipulate/curate and exploit the image and activities of said selves, is what allows the post-Internet mediation of the self to operate within a previously impossible level of mediation. The extent of the mediation of the self, post-Internet is constantly expanding and with it expand implications relating to privacy, freedom and control.

The transformative possibilities of the self, online, whether that is in visual appearance, behaviour or action (Cleland 2010), allow for unlimited versions of the self. At the same time, the level of control or lack of control over these versions of the self, allows for new levels of embodied identities. The self as data, the self as avatar, the self as image, are all extensions of the self, contributing to new ways of seeing the self. The self post-Internet is mediated and extended and with it are our ways of seeing and understanding the self itself.

James Bridle's 2015 artwork *Citizen EX* (Figure 2), examines the concept of algorithmic citizenship. The concept of algorithmic citizenship is based on the work of John Cheney-Lippold, first outlined in the 2011 journal paper 'A New Algorithmic Identity: Soft Biopolitics and the Modulation of Control' which discusses the capacity of computer algorithms to infer categories of identity upon users based largely on their web-surfing activities (Cheney-Lippold 2011). Bridle's algorithmic citizenship is described as a new form of citizenship which is not assigned at birth, or through complex legal documents, but through data. "By downloading a browser extension, you can see where on the web you really are and what that means. As one moves around the web, the Citizen Ex extension looks up the location of every website visit. Then by clicking the Citizen Ex icon on the browser's menu bar, one can see a map showing where the website is, and one can also see their algorithmic citizenship, and how it changes over time with the websites they use" (citizen-ex.com).

> *Citizen Ex* calculates your algorithmic citizenship based on where you go online. Every site you visit is counted as evidence of your affiliation to a particular place and added to your constantly revised algorithmic citizenship. Because the Internet is everywhere, you can go anywhere – but because the Internet is real, this also has consequences... Like other computerised processes, it can happen at the speed of light, and it can happen over and over again, constantly revising and recalculating. It can split a single citizenship into an infinite number of sub-citizenships, and count and weight them over time to produce combinations of affiliations to different states (Bridle, 2015).

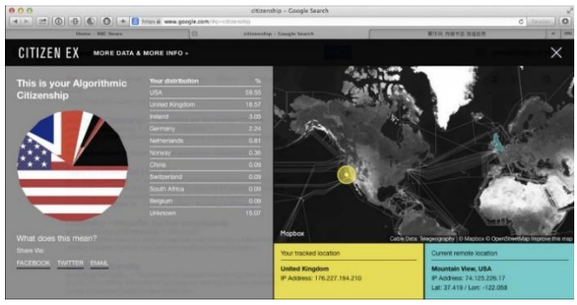

***Figure 2**: Citizen Ex, James Bridle, 2015. Available at: http://citizen-ex.com/*

Heath Bunting's ongoing artwork *The Status Project* (Figure 3), exposes how easily and comprehensively our movements and activities may be tracked when we provide personal information such as our name, e-mail, postal address or credit card details for even the simplest of Internet transactions (www.tate.org.uk). *The Status Project*, surveys a class system of human being management that produces maps of influence, flow charts of integrated logic and personal portraits for both comprehension and mobility. The class system has three layers, human being, natural person (objectified human being) and artificial person (generally objectified collectives of natural persons). Human beings can possess one or more natural persons and control one or more artificial persons and they are categorised in three different classes. Lower class human beings possess one severely reduced natural person and do not control any artificial persons. Middle class human beings possess one natural person and perhaps control one artificial person. Upper class human beings possess multiple natural persons and control numerous artificial persons with skillful separation and interplay. Some people have used *The Status Project as* a way to gain access to services, others use it to talk about identity issues and hackers see it as a source code to the system (Bunting 2007).

***Figure 3**: The Status Project, Heath Bunting, 2007-ongoing. Available at: http://status.irational.org/anonymous_corporation/*

The Status Project, is a study of the construction of our 'official identities' and creates what Bunting describes as "…an expert system for identity mutation". The work explores how information supplied by the public in their interactions with organisations and institutions is logged. The project draws on his direct encounters with specific database collection processes and the information he was obliged to supply in his life as a public citizen in order to access specific services; this includes data collected from the Internet and information found on governmental databases. This data is then used to map and illustrate how we behave, relate, choose things, travel and move around in social spaces. The project surveys individuals on a local, national and international level producing maps of "influence and personal portraits for both comprehension and social mobility" (Garrett 2012).

4. MEDIATED TRUST

Trust in persons, institutions and systems is to a considerable extent, the outcome of mediated processes (Endress 2002). Specifically, communication of information, which is inherently a mediated process, is a determinate factor to how trust is built and developed. As the Internet has increasingly become the main space for communication, circulation and retrieval of information, a trust intermediary (Schäfer 2016), it has also presented important new developments on how trust is being determined and affected by the heterogeneity of online and digital media. Information is embedded in a flurry of heuristic cues such as 'likes', 'shares' and 'comments' which may influence how trust indicators are taken up (Anderson et al. 2014). At the same time, the platforms where information is being communicated and circulated are themselves objects that people can trust or distrust.

Since the birth of the Internet, there has been a constant state of tension between digital freedoms of expression and association, authoritarian restrictions on information and communication access and the development of Internet framing policies and national and international web and Internet public and private regulations. This level of tension is telling of the importance of continuing to expand our understanding of how trust in persons, institutions and systems is affected by Internet-related mediated processes. Acts and movements of critical practice and resistance like hacking, building of free software and open-source communities, digital resistance techniques and training sessions and circumvention devices and techniques, are all indicators of the complex trust/distrust issues that keep emerging. Early Internet art, net.art, is a great example of how artworks were directed towards exposing and by-passing the economic, juridical and technical obstacles restricting free data and information exchange and free development of software (Dreher 2015), demonstrating who how and which interests determine net conditions of the time. Post-Internet art has also been dealing with contemporary issues around control, power, trust and their processes of mediation. Subjects and themes associated with post-Internet artworks are trust in technologies and platforms, interpersonal trust/authenticity, trust in systems and governance and trust in information (disinformation/misinformation). Some of the methods post-Internet artists use to approach trust today are as follows: identity play, audience manipulation, critical interventions/hacktivism, algorithmic play, network mapping and social media propaganda.

Benjamin Grosser's 2018 artwork *Safebook* (Figure 4), is a browser extension that makes Facebook 'safe'. The artist asks "Given the harms that Facebook has wrought on mental health, privacy, and democracy, what would it take to make Facebook "safe?" Is it possible to defuse Facebook's amplification of anxiety, division, and disinformation while still allowing users to post a status, leave a comment, or confirm a friend? With *Safebook*, the answer is yes!" (https://bengrosser.com). The *Safebook* browser extension is Facebook without content where all images, text, video and audio on the site are hidden. What is left behind are the empty boxes, columns, pop-ups and drop-downs that allow for the 'like' and 'react' features. The user can still post, scroll through an empty news feed and do everything that they would normally do on Facebook. Grosser asks "With the content hidden, can you still find your way around Facebook? If so, what does this reveal about just how ingrained the site's interface has become? And finally, is complete removal of all content the only way a

social media network can be safe?" Maybe the only way to keep Facebook – a platform that has been criticised for being complicit in and a space for spreading hoaxes and misinformation – from harming us is to hide everything (Ohlheiser 2018).

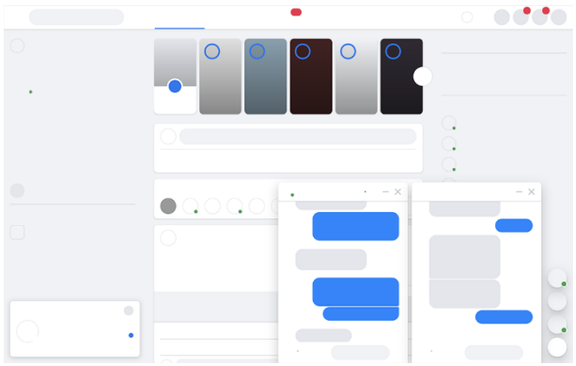

***Figure 4**: Safebook, Benjamin Grosser, 2018. Available at: https://bengrosser.com/projects/safebook/*

Grosser has been developing several tools that allow social media users to experiment on them and learn more about how social media experiment on their users. *Twitter Demetricator*, is another browser extension by Grosser that hides all metrics on Twitter like followers, likes and retweets.

> Those who engage in propaganda and disinformation campaigns understand, at least intuitively, that follower and other metrics on Twitter create new opportunities to manipulate public opinion...Bot armies and humans alike are used to inflate follower metrics, to elevate specific hashtags, or to like and retweet posts with a specific viewpoint. These disinformation tactics work because we're focused on the metrics and let them stand as an authority, as meaningful in and of themselves (https://bengrosser.com).

Twitter Demetricator is used as a tool that allows users to think critically about social media. It is up to the user to reflect on how visible metrics affect the way we behave and interact on social media. Visible metrics are designed to draw our attention, they can influence and even guide the how, what and when of our posts as users learn what works best in terms of approval and engagement by the users. "Indeed, it's almost impossible to comprehend just how central metrics are to the Twitter experience until you install *Demetricator*. Only when I tried it, did I realize that my eyes were instinctively flicking to a tweet's retweet and favourite counters before I even processed the tweet itself. Only when I tried *Demetricator* did I understand how much I relied on those signals to evaluate a tweet—not only its popularity or reach, but its value" (Oremus 2018).

5. CONCLUSION

Both the level and nature of mediatisation processes have changed as a result of the social, economic, cultural and political developments in relation to the Internet. How the physical becomes digital through digital reproduction processes or how physical reality is being represented in digital space has been an important area of scholarship during the first wave of widespread Internet use and adoption of digital technologies. In post-Internet times, however, mediation is considered a precondition for most areas of social activity. Analysing the complex and hybrid processes of mediation in the post-Internet condition requires a broad examination of the myriad of intra-actions between human and non-human actors which operate by constantly exchanging and diffracting, influencing and working inseparably (Barad 2007).

As mediation is an important dimension of the post-Internet condition it is also a common theme in post-Internet artworks. The three main areas of mediatisation as observed by the processes of reviewing Internet artworks and discourse around the post-Internet, are mediated publicness, mediated self and mediated trust. The artworks discussed in this section help illuminate the processes, dynamics, tensions and experiences of mediation in the post-Internet condition. Performing for social media audiences' expectations, critically manipulating social media applications, engaging Internet users globally in peer-to-peer networks, developing new methods that examine identity as defined by algorithmic processes and developing a platform that attempts to manipulate public opinion, are all perfect examples of how important the role of mediation is for our understanding of the world and of ourselves and how vital it is to continue to explore and critically engage with its processes.

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Post-Internet Art in Russia as a Digital Folder in the World Practice

Alexandra Orlova
Moscow, Russia
aocifra@gmail.com

Elvira Zhagun-Linnik
Moscow, Russia
elvirazhagun@gmail.com

1. INTRODUCTION

The everyday experience of life within computal societies inspires a search for new concepts, especially, neologisms using prefixes – post-digital, metamodernism, post-internet and etc. Concept of post-media (Felix Guattari “Soft Subversions”, Rosalind E. Krauss “A Voyage in the North Sea. Art in the Age of the Post-Medium Condition”, Peter Weibel “Postmedia Condition”, Lev Manovich “Post-media Aesthetics) was the first attempt of understanding the new reality of experiences of computational infrastructures and new aesthetic, new atmosphere of digitalization.

The “post-media” term turns out the starting point of recognition of the digital revolution where the prefix “post” (Lyotard theory) is the process of analysis. Florian Kramer uses the prefix “post-” in the term “post-digital” as an extension, a shift, a variety of reactions to digitalization when shift means process, procedurality, body-sensory perception and direct interaction and communication with the medium itself. This situation eliminates the distinction between reality and virtuality that close to metamodernism positions. This way, post-digital and metamodernism can be taken as complementary aesthetics of our mixed reality. In this sense, such hybridity puts forward its principles of post-irony, truth, openness and simplicity of the method on the basis of a synthesis of modernist and postmodern strategies, combining all their mutual oppositions, which is expressed in the framework of post-internet art.

2. THE RUSSIAN QUESTION

The history of Russian contemporary art cannot be described as a solid line where every style and movement developed one from another. “Sporadical” would be a more appropriate word to describe it. A burst of avant-garde movements in the beginning of the 20th century was rigorously shut down for several decades by the ruling party. During the period of 1957-1988 contemporary art in Russia was a sort of underground movement that was not appreciated by the members of the official creative unions. The situation started to change after the USSR fell apart. It was a starting point for independent art that was able to speak openly on any kind of topic and not being afraid to pay a price of freedom for it.

The moment media was discovered by Russian artists they started to get closely involved with it. This new language allowed to investigate opportunities in the digital sphere.

2.1 The Pioneers of digital reality

If we look closely on some of the pieces produced by such artists like Vladislav Efimov, Aristarkh Chernoshov, Alexey Shulgin, “Where Dogs Run?” group started working during the 1990-2000s. We can see that their main interest is closely connected with the aesthetics of digital area.

Humorous installations produced in the early 2000s by Vladislav Efimov and Aristarkh Chernyshev allowed gallery visitors to smash the artists by stepping on them with Terminator’s foot and blow them like a balloon. These playful pieces allowed people to interact with a contemporary art work in a fun way. Every single one of them became an object and a subject at the same time.

But we could already see how they moved toward the post-internet space. E.g. Alexey Shulgin made a performance, where he parodied a rock-star, but instead of the guitar he was playing a computer keyboard.

Yekaterinburg art-group “Where Dogs Run?” are a rare example or artists who work with tech not only for projects. They constantly produce installations and objects that analyse the reality we live in and what cultural heritage we have, or theories of different philosophers they find to be interesting.

3. DEFINING POST-INTERNET

Post-internet regards the net as base on which works are build. The same situation we have with post-digital. The relationship and influence of post-Internet and post-digital is the same as that of net art. But if net-art and digital conceptualised themselves exclusively online, then post-Internet and post-digital are both movements looked for a way out to the materiality and objectness.

Post-Internet art abandons not only the concept of medium, but even post-medium. Because of the world is hybrid, fluid where medium-specificity, software-specificity and site-specificity constantly replace each other. Now we can describe one artistic statement in all three ways simultaneously and/or in turn. Today images and information are circulation and does not belong to one once and for all fixed single place. David Joselit calls such objects and events emergent – that is dynamic appearing in the process of circulation. So Post-internet art must be understood through the concept of network surfing as a kind of base a foundation.

The term "post-internet" was first used between 2006-2008. American artist Marisa Olson began to describe concept of her artworks. She thinks all art today is a post-internet art because of we cannot ignore the influence of Internet culture on art and everyday life. Olson understands it as after the Internet, where "after" means "in style". “In both the article and live discussion, I made the point that I felt what I was making was ‘art after the internet.’ Pressed for an explanation, at the panel, I said that both my online and offline work was after the internet in the sense that ‘after’ can mean both ‘in the style of’ and ‘following.’ For illustration, I referred to the concept of postmodernity coming not at the end of modernity, but after (and with a critical awareness of) modernity” (Olson 2014, p. 60).

But Post-internet Art is reflexive in relation to the technical and artistic possibilities of artistic production. Artists are engaged in stylization but in conceptualization of contemporary imagery, which is influenced by the Internet and digital technologies, when Internet have discontinued to be something new and frustrating, but rather a banal, everyday reality. And we need to remember that art is still a symbolic system which constructed by the conceptualization in this way technologies, networks, conditions and environments in which images circulate.

The main idea that post-internet art combines technology and concept, where technology begins to play a much smaller role than context and idea. Jennifer Chan noticed “Post-internet is the bastard child of net.art and contemporary art” (Chan 2014, p. 110). Post-internet art continues the tradition of Duchamp's appropriation. It changed only the environment and objects. For artists of post-internet art the internet and its logic begin to be conceptualised with reference to the environment itself, where artists rethink, reinterpret and transform already existing images and events into works of art. The Internet becomes just a starting point for creativity, which begins with surfing, with searching for an idea. “Post-internet practices are characterised by hybridity and hyper-mediation of existing genres, platform-oriented activity, slippage between formal output of digital and physical environments, and tactical web surfing <…> artists who have been called ‘post-internet artists’ can be considered alchemists. They take stock of the rubbish heap of net history. They turn shit into gold by compressing and decompressing digital artefacts, rehashing them into something informative, intellectually abstract, and visually elegant” (Chan 2014, p. 110).

The most popular “rubbish” in digital space is the glitch – post-digital aesthetic. Or new dirty media. Post-digital aesthetic refuses to recognise the ideality and perfection of a digital object. This rejection brings post-digital aesthetics close to the practices of deconstruction, deformation and abstraction in the culture of modernism (Andrews 2000).

4. YONG ART CONQUERS THE POST-INTERNET SPHERE

If we look closer at the Russian example, we can try to highlight several waves that have their own peculiarities. Andif the 1st one was just trying to understand themselves in the new world of progressive media, the 2nd wave, represented by Ahmed Faig, Egor Kraft, .:vtol:. (Dmitry Morozov), Lena Romenkova work with post-digital in a way where they realise this field of art.

Young and emerging artists like Katerina Ser’yoznaya, Evgeniya Sterlyagova, Ekaterina Popovich, Christina Pashkova don’t see that area as something extraordinary. It’s the language they speak on. The other interesting fact is they are what we call institutionalised artists, whose mentors were people like Chernishov, Efimov and Shulgin. This way we can see try to find some evidence of a post-internet school in Russian art in the Future.

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How to Communicate Complex Spatial Itineraries: A balancing act between diagram and simulation

Dominik Lengyel
BTU Brandenburg University of Technology Cottbus-Senftenberg
Konrad-Wachsmann-Allee 4
03046 Cottbus
Germany
lengyel@b-tu.de

Catherine Toulouse
BTU Brandenburg University of Technology Cottbus-Senftenberg
Konrad-Wachsmann-Allee 4
03046 Cottbus
Germany
lengyel@b-tu.de

This paper shows our method of visually conveying the intricate pathway system of the unique amphitheatre in Durrës, Albania, in a way that allows visitors to experience the spatial implications for the ancient world. In the firm conviction as architects that architecture can best be understood when it is experienced, but that a destroyed building can no longer be witnessed, we have elaborated a method that does justice to this circumstance. In the communication of archaeological knowledge, the combination of find drawing, schematic illustration and descriptive text is often relied upon. Recently, perspective computer-generated drawings have entered the picture. What remains unresolved, is the perception of space as a process. Technology has not yet reached the point where a virtual world that deceives all the senses could simulate actual spatial perception. And so here, as in perspective composition, it is necessary to compensate for the actual perception of space by means of targeted image guidance by the film camera in such a way that a plausible impression of space is created. In addition to the composition criteria of point of view and angle of view, from which the focal length then arises, as well as the tilt-shift lenses for the compensation of the sense of balance, that is, that the recognition of the vertical is reproduced exactly in the image, and finally image framing, dynamic criteria are added. These are first and foremost the speed of movement, which has a considerable influence on the perception of the dimension, above all the length of the path travelled, but also the speed of rotation during changes of direction and, and here it becomes particularly demanding, the rotation as well as its speed before, during and after changes of direction, since the gaze does not run tangentially to the direction of movement, but anticipates changes of direction of the path, similar to directional headlamps in certain cars. In the end, the viewer receives a lasting impression that comes as close as possible to the archaeological hypothesis, but at the same time creates a spatial impression from an architectural point of view.

Visualisation. Archaeology. Architecture. Uncertainty. Scienficity. Itinararies. Mediation. Animation.

1. INTRODUCTION

At the London EVA 2020 (Lengyel 2020) we introduced our method of visualisation of hypotheses as a counter-position of presumed reconstructions of architecture. It emphasises that archaeological knowledge consists of a wide range of uncertainty including contradictions rising from multiple equally valid scientific assumptions. Instead of pure diagrams we work with subtle indications, mainly through versatile geometric abstraction. Contrary to the literal meaning this does not mean leaving things away but designing new and evident shapes of representation. Abstract shapes are then compensated by virtual architectural photography. The projects shown included works for the German Archaeological Institute (DAI) and several museums e. g. of the State Museums of Berlin and have always accompanied and enriched archaeological research (Figure 1).

At the London EVA 2021 (Lengyel 2021) we presented a project that goes beyond this. Funded by the Gerda Henkel Foundation for the Humanities, and developed in close cooperation with Henner von Hesberg and Heinz-Jörg Beste, it answers questions on the amphitheatre of Durrës that have arisen during the last decades of archaeological research by the Rome department

of the DAI. Durrës is situated the in today's Albania, a harbour city on the road between Rome and Constantinople (Figure 2).

***Figure 1**: Water basin in the Palatine Palaces of the Roman emperors at Flavian times*

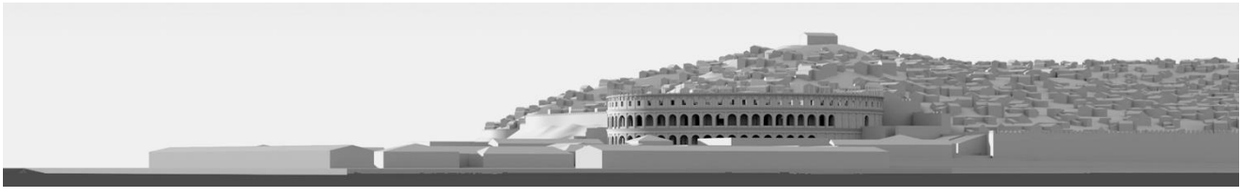

***Figure 2**: The hypothetic vision of the amphitheatre of Durrës from the sea*

The particular problem is that the orientation of the amphitheatre negates the supply provided by the topography. Its axes are indeed twisted. As a result, the accessibility is more than complicated, it is actually complex (Përzhita et al. 2014, Di Filippo et al. 2009).

2. THE FRAMING OF THE PHENOMENON OF MOVEMENT THROUGH SPACE

2.1 Complexity of the pathways

The aim was not merely to provide information about how the pathway might have been laid out, because diagrams in the form of floor plans, sections with graphic indicators for the differences in length, winding, stair gradient, etc. would have sufficed for this. No, we focused on the complex spatial impressions that, like an architectural design, go beyond what is objectively measurable, not because we are convinced that it could not be measured, but because we are convinced that the complexity that can be experienced is far ahead of what can be measured, and we cannot foresee when we will be capable of defining the parameters that would have to be measured in order to model this complexity. Beyond the fact that the measurability is lagging behind, we are convinced that now already the perceptible impression of space, even in the geometric simplification presented here, raises research questions in archaeology as well as in architecture that would not have arisen from diagrams or even just plans alone.

2.2 The phenomenon of spatial impression

Floor plans and sections, but also the non-planimetric and more analytical projections, the axonometries, should nevertheless supplement the perception of space here. In principle, their interpretation is only apparently more unambiguous than that of perspective projections, which are closer to natural visual perception, but even planimetric projections do require some experience and are often perceived and understood as being ambiguous or even misleading. Even axonometries only seem to be a compromise here, as they certainly convey spatial information, but only seem to convey a spatial impression. In order not to leave the central concern, the exploration of the corridor system, to linear wandering, we have placed the planimetric information, supplemented by diagrams, alongside the perspective projections, just as a visitor would create a plan with a height profile for himself and a diagram to compare the pathways and then subject them to analysis. The sum of the information compiled here thus represents the overall recording of the hypothetical complete building from the first inspection through revisions to sketches, plans and diagrams, that is, from experience to analysis. The complete conception of the building is to be revealed to the viewer. Our aim is the natural walk-through as a visitor, which means from natural eye level in natural movement.

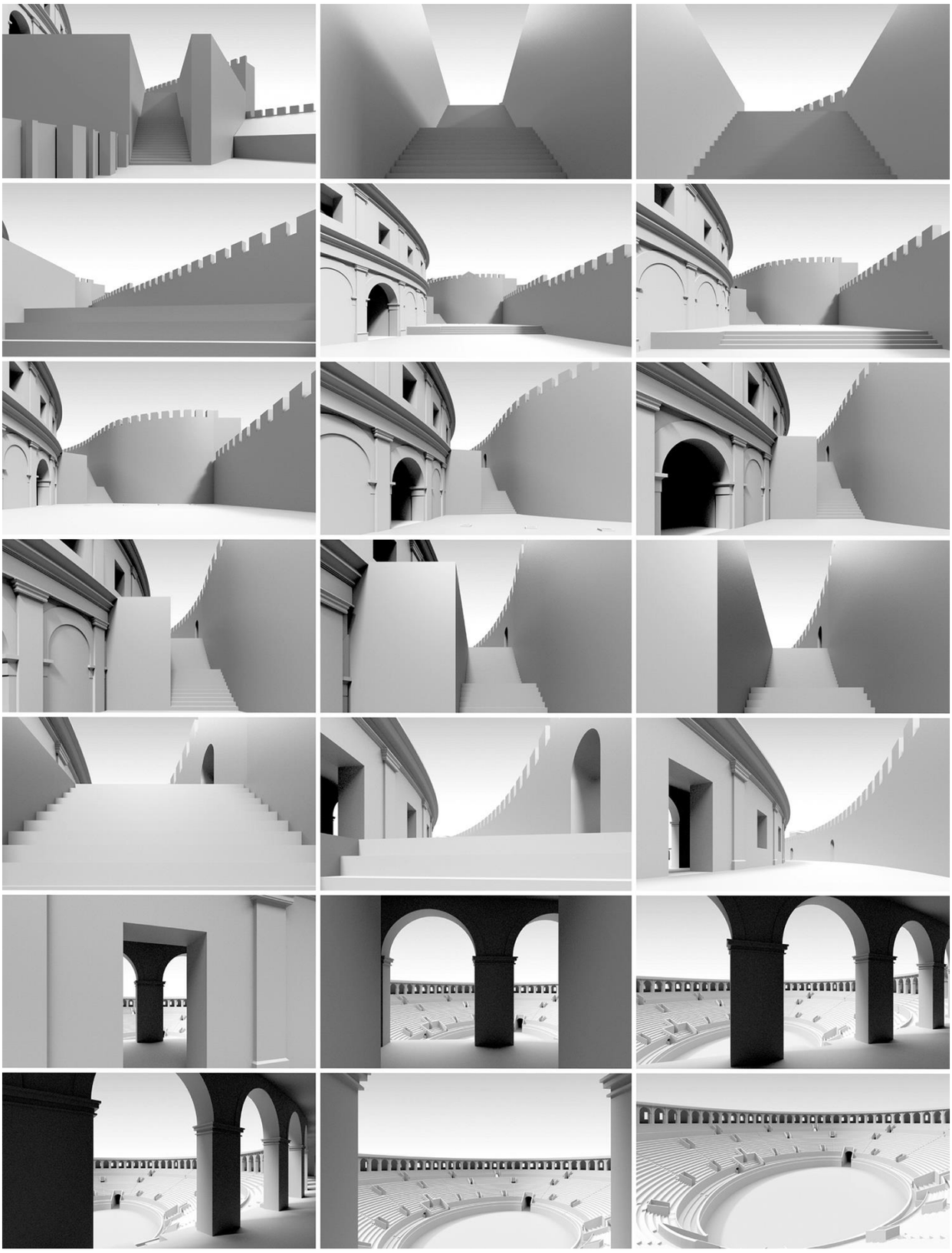

Figure 3: *Hypothetical external access route to the top seating row on the hill side of the amphitheatre*

2.3 Visual orientation

Defining the paths, that is the movement paths themselves, is linguistically very simple to start with. After all, it is only a matter of getting from one place to another, and in our case that is from the forecourt of the amphitheatre to the seating area and vice versa. Nevertheless, the path cannot be described with the aim of conveying it as plausibly as possible as a simulation, because the actual walk through such a sequence of spaces would be characterised by unexpected visual impressions that would result in a searching gaze, especially at path crossings, looking around for orientation and correspondingly spontaneous changes of direction. In contrast, the claim of a linear film, which is at first not yet an interactive walk-through of the virtual model, but instead is intended to be a dramaturgical narrative, also so that it can be presented in the museum in such a way that no technical devices such as VR glasses are necessary, is to suggest to the viewer to follow that path. Also, the intended comparability of the pathways requires a movement that is as idealised as possible, as the comparability should allow one to experience how the circuitous pathways of this amphitheatre compare to the simple, actually optimised pathways of this but above all of most other amphitheatres. It should also be possible to walk along the different pathways several times one after another and still focus on comparability, which would also avoid spontaneous, i.e. realistic, but also unique impressions, as they would only be realistic on the first occasion, but would be distorting the second time. As in the abstracting modelling of architecture, this meant that in the routing of paths, and even more so in the routing of views, there was the aspiration to be valid in a generalising way, and just as a familiar space is walked through more and more similarly to one another with increasing iteration, so the idealisation of routing of paths and views aims precisely at this: at the idealised passage with idealised routing of views. At the same time, however, the focus should be on the casual visitor, not, for example, the guard or the courier, who would be able to traverse the path safely to a certain extent asleep, or at least in complete darkness. As with the careful balancing of the abstraction of geometry against the minimum of concreteness in favour of a coherent architectural vision of space, the challenge here was to find a balance between, to put it sportingly, an ideal line and intuitive navigation through a partly complicated system of corridors. In terms of fictional roles, and to make the abstraction even clearer, two deliberate examples from our time in mind here, it was a question of finding a balance between caretaker and tourist, as mentioned, and this is important, not for the sake of the roles, but for the sake of the spatial impression, which should turn out to be generic and specific at the same time, just as the entire geometry of the hypothetical completion of the image of a sparsely preserved amphitheatre oscillates between a generic and a specific solution.

2.4 The relevance of idealisation

The procedure was just as iterative as described above, it needed to be possible to move along the same path again and again without not being able to concentrate independently and intuitively sometimes on one and sometimes on the other. The even speeds, adapted to the circumstance of whether or not stairs have to be surmounted, allow the experience of the space to concentrate either on these speed patterns or on the geometry of the sometimes abrupt changes of direction or on the very different light conditions of the path or the depth of the view, or on the immediate geometry, the height and width of the room, the curvature of the vaults, the gradient of the stairs. Idealisation thus leads precisely to experiencing the space differently, just as it is possible to follow individual voices when listening to a composed symphony.

2.5 The necessity of iteration

The procedure had to be iterated because of the complex interplay of position and motion vector with the direction of gaze and that vector's motion, as well as the lens corrections that this necessitated, especially the shift-tilt effect, which is just as necessary in still images as it is in moving images in order to simply correspond visually to the actual spatial perception of, for example, vertical room edges. In order to take into account the equally important factor of navigation, even if it is only that the virtual visitor should also see when he is on a staircase, another difficulty was to open up the viewing angle sufficiently without having to face surreal distortions in the corners of the image. The supposedly simplest way of using a fisheye lens is as much excluded with regard to a natural perception of space as a lively panning of the picture plane.

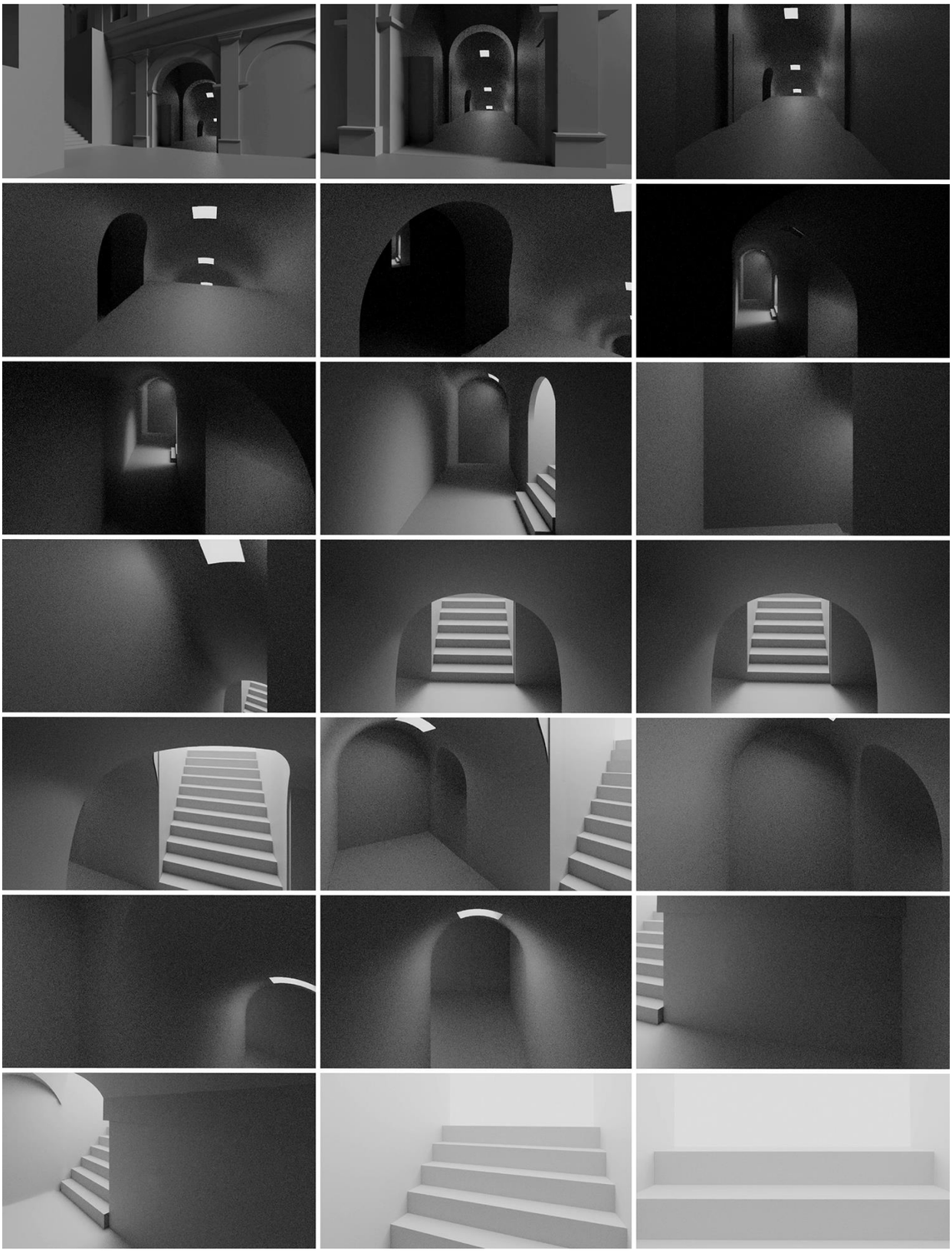

Figure 4: *Hypothetical internal access route to the lowest seating row on the hill side of the amphitheatre*

3. CONCLUSION

In the end, the result is a camera movement that was for the most part manually adjusted. Of course, this impression should not be created, and so the result can also be described as visually simulating a passage through a physical space, as an experienced visitor would perceive, i.e. experience it, confidently and leisurely, with a calm view and a set destination – and additionally equipped with a gimball hand stand, which merely compensates for the movement of the head caused by the walking motion.

This form of idealisation as a consistent continuation of abstract modelling naturally has to rely on our acquired habits of seeing. It demands from the viewer both an openness in interpreting the forms as architecture and the idealised image sequences as an offer to undertake a visual journey through architecture that is both open to interpretation and suggestive.

4. OUTLOOK

In ongoing research projects together with Stefan Schwan and Manuela Glaser at the Leibniz Institute für Wissensmedien (IWM) in Tübingen, Germany, we are using such scientifically based abstracted architectural models to explore the effects of camera movement in space, up to the present related to the centred zoom movement (Glaser et al. 2017). However, the measurable comparison parameters must first be defined for the experimental psychological evaluation of the theses put forward here with regard to the complex movement and gaze guidance in animated walk-throws as described in this paper.

Obviously, the medium of text publication with still illustrations, even if these are made in the form of storyboards, cannot reproduce the effect of the film sequences described. However, the complete educational film will be published on The Science Portal of The Gerda Henkel Foundation (L.I.S.A.).

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Design for Digital Humanities Practices Focusing On People With Visual Impairment

Mônica Moura
UNESP/Bauru
São Paulo
monica.moura@unesp.br

Cristina Portugal
PQ/Cnpq
Rio de Janeiro
cristina.portugal@pq.cnpq.br

Márcio Guimarães
UFMA
Maranhão
marcio.guimaraes@ufma.br

Iana Uliana Perez
UNESP/Bauru
São Paulo
iana.uli@gmail.com

José Carlos Magro Junior
UNESP/Bauru
São Paulo
j.magro@unesp.br

This work is an unfolding of the paper published on Eva London 2021, where the pilot Project "Lembrei de Você (LDV)" – "*I remember you",* which aimed to create a network of people who would support one another during pandemics using online technologies This paper goes a step ahead and discusses the proposal of a platform based on the feedback of studies carried out from LDV's pilot project aiming to create easier efforts in order to reduce the stage of solicitude of people in insolation, being them or not visually impaired one. The current study will address issues concerning the design and practices in digital humanities, as well as the methodologic processes for developing a communications and distribution platform for visually impaired people

Inclusive design. Accessibility. Visual impairment. Digital platform. Pandemic. Post-pandemic.

1. INTRODUCTION

The social distance caused by the Covid 19 pandemic exacerbated the problems associated with loneliness among people with disabilities or in social vulnerability situations. The observation of this reality revealed the need to establish a support network for people with and without visual impairments, promoting autonomy and well-being through scientific-technological advancement. We identified the need for effective communication, interaction, and an integration support network system based on inclusive design, the digital humanities manifesto, and previous research consequences and results.

Inclusive design refers to research and development that promotes democratic access to products, services, and systems that provide comfort, care, and quality of life for those who use them. These premises guided the pilot project " Lembrei de Você (LDV)" – I Remember You (LDV)", a network of co-responsible volunteers who organise, read, record, and send audios to people with or without visual impairment who are lonely and socially vulnerable.

The LDV pilot project, which currently serves four institutions and 800 people, highlighted the need for new studies and scientific and technological development to create an appropriate system for disseminating, facilitating, and optimizing the accesses and processes involved.

The specific issue pertains to the development of a system within the scope of socially inclusive design that integrates oral and sound relations and collaborates in stimulating autonomy, providing reception, and improving the daily satisfaction of the public served.

Participants in the LDV pilot project back up the evidence of plausibility. Their reports demonstrate the effectiveness of the sensitive and memorial experience: the audios received provided entertainment, comfort, and well-being.

The theme is essential for the field of knowledge because it reaffirms the contribution of design to society, particularly for people with visual impairments or who are socially vulnerable.

The project employs processes of co-creation, participation, and collaboration of the subjects involved, based on social design methods that highlight the designer's role in the face of problems in the Brazilian reality and social context. In this sense, the results demonstrate the effectiveness of inclusive design, which is socially responsible and human-centred. They also contribute to current social, cultural, and technological innovations.

Thereby, we will adopt the methodological procedures of participatory research and the social design practice model. This approach includes planning phases, preliminary studies, commitment, evaluations, critical analysis, investigations, efficiency and effectiveness analyses, estimates, implementation, transformation actions, finalization, dissemination of the generated results. The sub-phases are as follows: awareness and knowledge about the problem and reality of those assisted; participation for a joint solution; interaction promotion; problem analysis; generation of needs; prioritization of emergencies; brainstorming in search of a solution; definition of goals and objectives and planning of those involved in the process; assessment of the dynamics and overall process through interviews with the public served, volunteers, and staff. Finally, the results will be produced and scientifically disseminated. The method used will be qualitative, with approaches such as bibliographic, documentary, and field research, as well as collaborative and participatory processes.

In this article, we will present the evolution of the work titled “Design in times of pandemics: accessible literature to people with visual impairment”, presented in the EVA London 2021, (MOURA et al. 2021), as well as the applied methods and preliminary studies for the development of the management system for the LDV project, ranging from issues related to the visualization of data accessible on the web to the visually impaired to the high-level requirements for the "Lembrei de Você 1.0 Platform".

2. DESIGN AND DIGITAL HUMANITIES PRACTICES

What is the current definition of the Digital Humanities? The digital era has been present since the Second World War; however, with the arrival of the World Wide Web, personal computing, mobile computing, and social medias, the digital revolution entered a new phase, giving birth to a completely expanded and transformed set of creation and knowledge dissemination possibilities (Burdick et al. 2020).

Design is re-signified and goes through paths that are always more alternatives to the initial conceptions that associated it only with industrial of graphic production by adapting to several innovative, cultural, social, and contemporary and dialoguing with different research fields. This project includes a reflection on the actuation of design centred on the human being, as well as some of its unfolding such as co-creation and other perspectives of actuation, which are supported by arguments derived from contemporary design discourse. On it, we reflect on the role of design in social contexts, particularly in an experiment in which the subjects who participated became co-responsible for the outcomes.

Katherine McCoy, Milton Glaser, Victor Margolis, and others present the actuation of the designer in projects prioritizing human development in the collection organised by Steven Heller & Veronique Viénne (2003), who emphasise the need for an ethical and critical posture of the designer in the face of contemporary problems, in a more intense actuation of the design police.

The central questions of this research are related to individual autonomy, social integration, helping to improve the lives of people with or without acuity quality, fulfilling the wellbeing of people with or without visual impairments, fulfilling the scope of inclusive design that is allowed by projectable or non-projectable materials, and ensuring equal opportunities for all people in society.

Visual impairment is defined by a decrease, loss, or lack of visual acuity in the visual field. These two ophthalmologic scales are concerned with the loss or incapacity of seeing at a distance (visual acuity) and the amplitude of the area covered by vision (visual field).

According to Ottaiano et al (2019), data from the global population show an increase in the number of blind people in the elderly (over 60 years) due to longer life expectancy. According to IBGE (2019), the elderly population in Brazil (2019) is expected to double until 2042, when compared to 2017, when the country had 28 million elderly people, or 13.5 % of the total population).

In light of this reality, and after reflecting on the main principles of design, we became concerned about finding solutions and contributions to improve the search for quality of life in order to improve people's well-being. And, in recent years, we have devoted a significant amount of time and effort to ways of designing that benefit people with visual impairment.

Williams (2022) states that people with disabilities will benefit significantly if the digital humanities community seeks inclusive projects and becomes serious about the importance of adopting principles. The author argues that inclusive design principles should be instilled in digital humans to influence a broader culture.

Considering what was revealed, the solution that we discovered to broaden the reach of the pilot project was the systematic and implementation of a digital platform of management and communication in order to interact in a collaborative and solidarity of defenders of self-esteem and motivation for the promotion of autonomy and social integration of people with or without visual impairment.

3. STUDIES ON DIGITAL PLATFORM FOR PROJECT "LEMBREI DE VOCÊ"

The integration of medias has grown significantly over the last few decades, giving the Web culture a multimedia flavour. It also encouraged the development of sharing models, co-creation, publication, and communitarian building, with the Web serving as the focal point of a social contemporary society. Because of smartphones, tablets, and other ubiquitous and pervasive media and computing, the concept of the Web as a public service extending public spaces has clearly intensified.

In view of this Web concept, the digital platform is being developed based on studies, analyses, evaluations, and surveys conducted, as well as the planning and execution of the beta version of such digital platform for the management of communication, content collection, and distribution for the visually impaired, including and targeting sighted people, because inclusive projects must meet and provide comfort to all. Nonetheless, it is expected that the findings will contribute to the development of autonomy and, as a result, the well-being and improvement of the quality of life of those involved in the study.

The platform will allow for the expansion of the scope of service to include more people and institutions that did not directly participate in the initial actions, as well as the generation of models to serve other Portuguese-speaking countries in the medium term.

The project team defined the high-level requirements for the development of the Lembrei de Você 1.0 platform for recording, validating, managing, and sending audios for both internal and external customers, allowing the platform's basic operating flow to be generated.

The World Wide Web Consortium's Web Content Accessibility Guidelines (WCAG) 2.0 define accessibility standards that focus on areas such as strengthening text alternatives for textual and non-text content using media resources to make it easier for users to see and hear content. Making all functionality available through the keyboard, including design for different reading speeds, usage speeds, and abilities to make the website look and feel predictable. Maximizing compatibility with current and future hardware and software including assistive technologies.

The following specifications were defined for the development of the platform with audio recording, validation, management, and sending functions, both for internal users and external clients via WhatsApp:

3.1 Web Platform

Mobile application (IOS and Android) for some modules. Accessibility for screen readers was provided, with modules as follows:

3.1.1 Readers / Readers

Module for content creation, where users record and send audios for evaluation.

- Web and Mobile
- Only authorised users
- Content library (digital collection with texts available for reading)
- Filters by type, author and title
- Authorization to use voice, rights and project policies on first use after being authenticated (mandatory)
- Audio recording
- Recording tools (start, pause, end)
- Audio category
- Recording Manual (script in tutorial format)
- Management of recorded audios
- Sending audio
- Audio deletion (for audios not yet uploaded)
- Audio delete request sent
- Status
- Not sent
- waiting validation
- Approved
- Returned for adjustments
- Refused
- News (interface for receiving multimedia messages, no interaction, filtered by user profile)

3.1.2 Audio curation

Module for managing the contents created by the readers module.

- Web only
- Only authenticated users
- Collection of audios (sent by the readers/readers module)
- Audio evaluation
- the player
- Audio recategorization (change of category)
- Audio validation
- Approval (optional feedback message)
- Rewrite request (mandatory feedback message)
- Deletion (mandatory feedback message)
- News (interface for receiving multimedia messages, no interaction, filtered by user profile).

3.1.3 Shipping management

Module for creating packages (from audios approved in the curation module) and managing submissions to listening users.

- Web only
- Only authenticated users
- Approved audio library
- Management of audio packages
- Package configuration
- Number of audios
- Automatic report generation (information on the audios that make up the package)
- Packet deletion (not yet sent to any listeners)
- Packet alteration (not yet sent to any listeners)
- Package inactivation
- Package shipping schedule
- Internal submission for platform listening users
- External shipping to WhatsApp
- News (interface for receiving multimedia messages, no interaction, filtered by user profile).

3.1.4 Listeners

Module for listening and sharing (spontaneously by listeners) the available audios and packages

- Web and Mobile
- Authenticated and Unauthenticated Users
- Library of available audios (recorded, validated and made available) and audio packages
- Filter by type, reader, author and title
- Player
- External audio sharing via WhatsApp
- Internal audio sharing for registered users
- Assessment of audio and packages (feedback “liked” or “disliked” + optional message)
- News (interface for receiving audio-only messages, without interaction, filtered by user profile).

3.1.5 Administrative

- Web only
- User management
- Access profile management
- Platform settings]

3.1.6 Contact

- Web and Mobile
- Only authenticated users
- Text message centre (asynchronous chat style)

3.1.7 About

- Web and Mobile
- Authenticated and Unauthenticated Users
- Project information page
- The methodological aspects that guided this qualitative investigation are present in the research process for the development of the digital system.
- To investigate, considering Design methodologies, means for the development of a digital project management system.
- To create the digital environment's information architecture based on characteristics that are divided into four large interdependent systems, each with its own set of rules and applications: Organization System, Navigation System: Labelling System and Search System
- To create navigational components that are easily accessible to people with visual impairments, such as menus, arrows, navigation nodes, hypertext, and images.
- To create digital platforms for Windows and IOS – (Project development under the perspective of Design methodologies).
- To conduct interviews with selected groups of professionals in the field of visual impairment. The results of observations made about the use of the digital platform will be analysed to reinforce, exemplify, and discover the question of effectiveness in the use of the product (Semi-structured interviews).
- To elaborate a prototype of the digital system
- To validate the digital map with professors of the medical field.

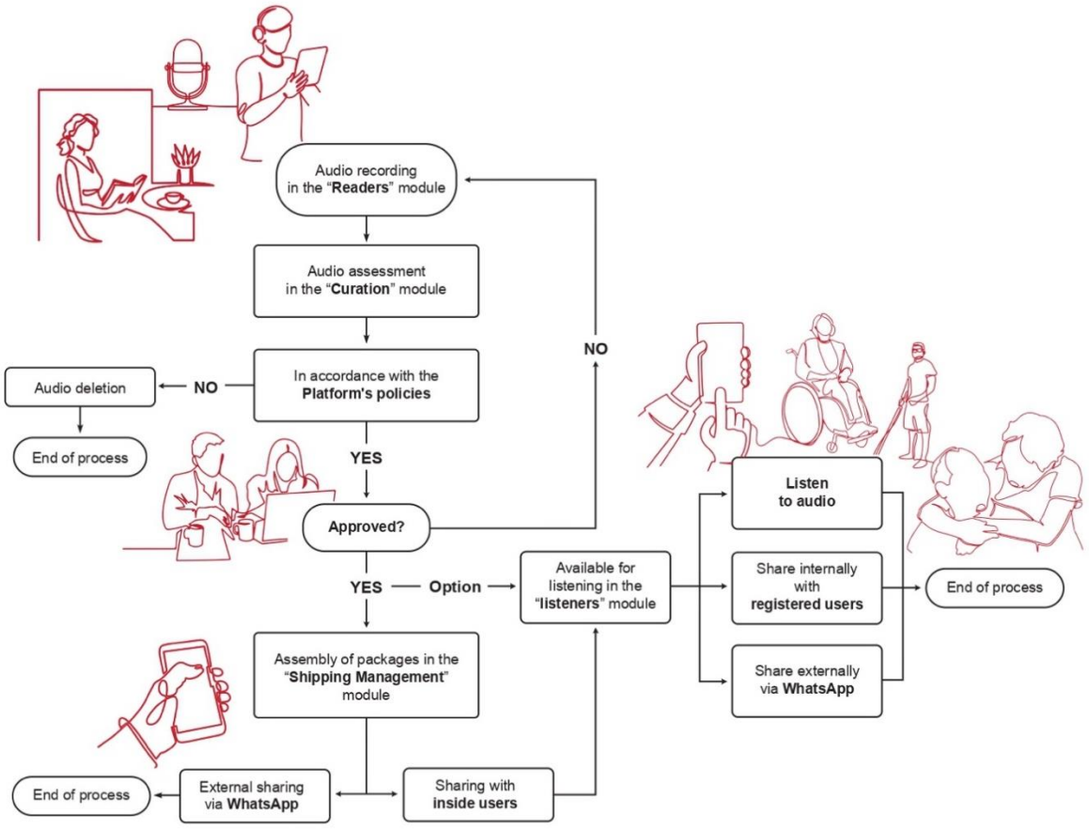

Figure 1: *Basic Platform Operation Flow. Source: Authors.*

Data are typically quantitative and measurable, making them easy to handle by computational processes when codified in digital language. As a result, we can use computational power to devise new methods of mapping those data in order to incorporate new interpretative meanings.

The visualization of complex data in digital environments, or the dynamic visualization of data, is one of the truly new cultural forms enabled by computing. (...) We can visualise very large data sets using computers, creating dynamic visualization, feeding data in real time, basing the graphic representation of data on their mathematical analysis, using a variety of methods ranging from classical statistics to data prospection, and mapping one type of representation into another (images in sounds, sounds in three-dimensional spaces, etc.) (Manovich 2004, p. 149).

4. CONCLUSION

The studies that we have developed make use of the Web's capabilities and show that, nowadays, design focused on social issues tends to explore the possibilities and challenges of understanding the human being in all of its complexity and diversity. The designer began to adopt an exploratory posture for projects, products, environments, services, and manifestos that will express the subjectivities of the subjects involved.

It is clear, both from the authors discussed here and from the basic design precepts, that the main focus of this area is the human being in all of theirs needs, singularities, diversity, and sensitivities. Thus, we believe that the great challenge of contemporary design is to be developed in a sphere that understands the complexity and diversity of people who live the reality of our time, of which one of the most prominent and also complex aspects is inclusion, particularly in these times of social isolation in the face of Covid-19.

Inclusion in design implies participatory processes. It is up to the professional in this mode of design to mediate the necessary interactions for the process, as advocated by Bonsiepe (2011) when arguing that autonomous production is an alternative to heteronomy and a restorative action, implying the formulation of more humanistic projects. According

to Manzini (2015), participatory practices mark the end of designers' imposing strategic position since the industrial age, granting autonomy to the subjects involved in the process.

Faced with this situation, the project presented here aims to promote inclusion through the design of actions that generate social integration of the individual and stimuli for the expansion of the perceptual, aesthetic, sensitive, imagery, and cognitive repertoire, allowing for the strengthening of self-esteem and aiming to build autonomy, dignity, and, as a result, citizenship in times of pandemic.

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Hy-breed: Growing a responsive organo-mechanical agent

Joel Ong
York University
Toronto, Canada
joelong@yorku.ca

1. INTRODUCTION

One of the considerations in the use of AI in the last years is its progression towards deeper, more opaque handling of data that are often hidden beneath increasingly smooth and 'user-friendly' interfaces. With its increasing use as a tool for automated decision making at the level of the consumer but also in the way sites of intense vulnerability such as detention centres and refugee camps have become sites for experimental testing of these new technologies (Molnar 2020), the pervasive reach of Artificial Intelligence within our socio-political infrastructures are raising our consciousness to the ways machines digitally represent our lives, activities, contours and movements, and the ways these are translated computationally as intent. Information theorist Philip Agre (1994) has considered the way these activities have formed a language in itself through "representation schemes" that use "linguistic metaphors and formal languages for representing... activities". (Anderson & Pold 2018). Such examples from motion tracking, migration and the collecting of micro-movements of the head, torso, hands etc through VR headsets encourage the inference of limited amounts of movement as intent. These reframe the reverberations of activity as a form of utterance, movement as digital conversations.

In this work I explore the co-existence of living microbes (Euglena Gracilis), and a rudimentary machine learning model to explore how designing a system for reading and understand motion, in particular non-human motion, might expose the inherent contradictions in the digitization of our bodies and selves.

2. HY-BREED

In its practical development, the project involves the cultivation of a hybrid machine-biological agent entitled Euglena, a fine tuned GPT-2 text engine controlled by a live dish of the freshwater alga Euglena gracilis. Beyond vital maintenance of the system, they are "trained" to perform together as a hybrid conversational AI system.

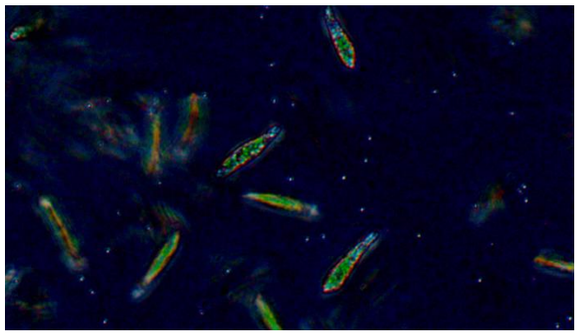

Figure 1: *Euglena Gracilis community at 400x magnification and phase contrast*

For Euglena, a container of the single-celled alga was purchased from Carolina Biological and instructions for keeping the community healthy included regular exposure to sun (it is photosynthetic) and ensuring that the cap to the container was opened to ensure aeration. As a robust microbe, E.gracilis is a very independent organism and has a high tolerance for environmental stressors. Its variegated responses to its environment are also well documented, in addition to moving towards light, it also exhibits extensive contortions of its body (metaboly) that while are methods for self-preservation, could also be framed as performative and expressive gestures. It was fascinating in this project because of its rapid responses to stimulus that were almost predictable, and at a time scale that was available to us as a human. "Circumstances" such as the evaporation of its liquid medium on the slides and cloudy weather) would cause it to change its shape and roll into a dormant ball. Similarly, in crowded and/or darkened dishes, it would spiral around seemingly looking for a way out. Using OpenCV through a variety of platforms, I was able to locate

the movement of blobs across the screen and also provide rudimentary understanding of the shapes of the E.gracilis (whether the contours tended towards a circle or if it was elongated), and from there was able to infer its emotional state.

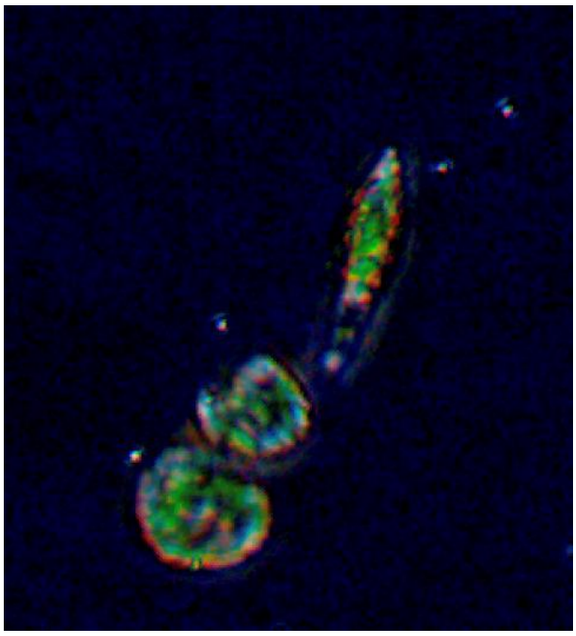

Figure 2: *Euglena Gracilis in spiral (left) 400x, and elongated (right) in response to lowering amount of fluid medium in the dish*

In breeding the mechanical – computational side of the project, my goal was to create a rudimentary conversational AI that would be able to respond to simple text prompts with comprehensible outputs.
I opted to fine tune an existing model instead of training one from scratch for this version. Starting with a 'gpt-2' model from Hugging Face's open source repository, I proceeded to fine-tune it using the "Transformers" module and instructions available on the website (https://huggingface.co/docs/transformers/training).
As an early test, and to generate content that resembled a poetic or abstract nature, I chose to use the writings of Samuel Beckett as my training dataset. (Of particular significance is the philosophical and temporal resonances in "Waiting for Godot" and the way this project could be seen as an existentialist conversation). The trained model eventually yielded 5 possible responses to a short prompt – this number was chosen to maximise its potential for a 'live' conversation, and lower the latency from input to output – and depending on the inferred and aggregated emotional state of the E.gracilis community, one of the outputs would be chosen.

This project was performed as a live conversation/panel with 2 other AI and Art researchers at the POM 2021 conference in Berlin, and presented as a stand-alone visualization at IEEE VISAP 2021. Further work will also be discussed at the paper presentation.

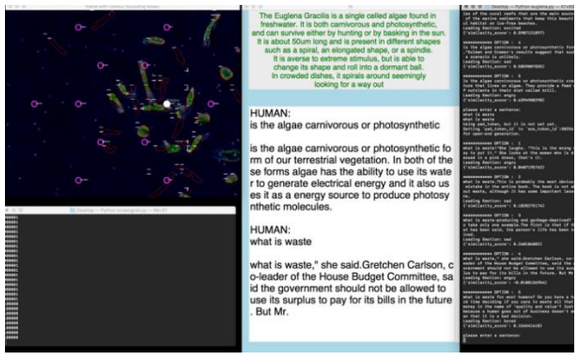

Figure3: *Screen capture of live performance, showing the live video feed of Euglena gracilis on the left, AI generated text on the right, and output of the system in the middle.*

3. CONCLUSION

I approach this research-creation practice through two lenses:

(i) The metaorganism – the body recontextualised as an object of knowledge, or better a 'resource of information' (Thacker, 2004).
(ii) The multispecies assemblages within the emerging paradigmatic computational planet (Gabrys, 2016) – a cybernetic vision of feedback and control that was increasingly validated through expansive networks of sensing technologies, and the mobilization of animals and machines in hyperlocal environmental monitoring at unprecedented scale.

Given the meteoric rise in AI and machine learning capabilities, a project such as this also allows a process of slow scholarship and an expanded aesthetic of care to take priority. A more drawn out process of learning, listening and co-inhabiting with these agents is currently underway and will be described in the paper presentation.

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Creative AI Futures: Theory and practice

Mercedes Bunz
King's College London
Department of Digital Humanities
Strand
London WC2R 2LS, UK
mercedes.bunz@kcl.ac.uk

Eva Jäger
Serpentine
Kensington Gardens,
London
W2 3XA
UK
evaj@serpentinegalleries.org

Alasdair Milne
King's College London
Department of Digital Humanities
Strand
London WC2R 2LS, UK
alasdair.milne@kcl.ac.uk

Joanna Zylinska
King's College London
Department of Digital Humanities
Strand
London WC2R 2LS, UK
joanna.zylinska@kcl.ac.uk

This paper analyses creative activity enabled by ML and recognised under the banner of 'AI art' or 'creative AI'. The theoretical discussion is anchored in the critical reflection on the activities in which the authors have been involved as part of the Creative AI Lab, which is a collaboration between the R&D Platform at Serpentine Galleries and King's College London's Department of Digital Humanities. The paper proposes a 5C model ('Creative – Critical – Constructive – Collaborative – Computational'), which brings together technical research and conceptual inquiry into AI art, while shifting focus from artefacts to their wider contexts, processes and infrastructures. It also outlines directions for future research.

AI. Artistic collaboration. Back-end environments. Co-creation. Creative AI Lab. Creativity. Critical theory. Future of art.

1. INTRODUCTION

Artists working in different media have been exploring AI's potential as a creative instrument, nonhuman collaborator and subject of social critique. In what follows, we want to stage a theoretical and practical discussion of the problem of artistic practice as enabled by AI and ML, while outlining new directions for future research. This discussion, we suggest, needs to consider a number of conceptual questions:

- To what extent does the current use of AI technologies in art making raise bigger questions about the very nature of artistic production and research?
- How is the role and agency of 'the artist' altered at a time when many artistic productions are the result of human-machine collaboration, with the creative output not being subject to human control but rather to the uncertain logic of a deep-learning algorithm?
- Does AI create new audiences for art – and does it require new skills from those audiences?
- Do we need new capabilities from our arts institutions in order to support and develop AI-driven art practices, and to enable its exhibition?
- What role can AI art practice play in exploring alternative versions of AI and in fostering its public understanding?

Importantly, for us a theoretical discussion of these questions is anchored in the critical reflection on the practical activities in which we have been involved as part of the Creative AI Lab (Serpentine 2020). Building on the Lab's existing collaborations, we want to propose a '5C' model for Creative AI practice and research as a more enabling approach to working at the cross-discipline of 'creative AI'. Mobilising critical inquiry with creative production and technical expertise, this model entails developing horizontal, non-competitive networks of alliances between academic and cultural institutions dealing with creativity, AI and ML.

2. AI ART NOW

The term 'Creative AI' comes from the technical community, which uses it to refer to the application of machine learning (ML) and other forms of AI for artistic purposes. The art world, in turn, prefers terms such as 'AI art' (Zylinska 2020) and, less frequently, 'ML art', 'computer art' or simply 'media art', while cognitive scientists talk about 'computational creativity' (Ploin et al. 2022, pp.10-11). Our own adoption of 'Creative AI' as a label for the work of our Lab, and for the proposal entailed in this paper, aims to foreground the technical and processual aspects of creative activity involving the widely conceived AI technology, while also signalling that, as part of our project, we are examining more than just artefacts.

Despite its relative novelty, AI art has already stabilised into a substantial subfield populated by practitioners who break down traditional disciplinary boundaries. This subfield is a 'loosely defined … movement' that is related to 'previous computational

artistic practices such as cybernetics art, artificial life art, and evolutionary art' (Audry 2021, p.21) – as well as data visualisation practices in design. Given the high level of expertise required of both artists and audiences in producing and accessing at least some of the artistic outputs produced in this vein, AI art has led to a further destabilisation of ecosystem roles such as artist, curator, technologist (engineer/programmer), theorist and producer.

Within the current AI art practice two dominant yet overlapping sub-strands can be identified: a visual one and a conceptual (or, better, integrative) one. As part of the first sub-strand, artists such as Memo Atken, Mario Klingemann, Anna Ridler and Refik Anadol are interrogating the new aesthetic possibilities of dreamlike generative worlds, as well as data visualisations which scrutinise widespread algorithmic tendencies and AI tools. Within the second strand artists and collectives such as 0rphan Drift and Etic Lab, Forensic Architecture or Danielle Brathwaite-Shirley are more intent on expanding the role of data or algorithms for art practice, with machine learning tools being integrated into broader artistic systems. These artists, while working directly with AI tools, are often less likely to position themselves as 'AI artists' first and foremost. The embedding of AI and ML *within* sensory apparatuses, video games and countersurveillance systems mirrors the technology's wider societal deployment, with a view to enacting Marshall McLuhan's dictum about art being 'an early distant warning system' (McLuhan 1964). While public and curatorial attention was initially captured by those generative practices and their bold visual aesthetics, with the rise in institutional expertise this subsequent class of 'integrative' works has now started receiving more critical attention.

These varied practices have provoked an extensive theoretical and art-historical discussion (Zylinska 2020; Audry 2021; Zeilinger 2021). Starting from attempts to conceptualise the operations of those creative, curatorial and technical practices facilitated by AI, it has also expanded to extant philosophical debates around authorship, agency and creativity. Theoretical work taking place in this field has impact beyond the specific subject matter of art practice, with adjacent scholars commonly working on the epistemology (Bunz 2019; Parisi 2019; Weatherby & Justice 2022), ontology (Fazi 2020; Amaro 2022), aesthetics (Manovich 2018) and ethics (Dubber, Pasquale & Das 2020) of machine learning.

The relatively new subfield of AI art is itself constantly evolving, in line with ongoing technical developments and societal issues. Most recently, it has been transformed by adjacent technologies (e.g. blockchain), which have had cultural impact on artists working with AI. Tracking, understanding and, at times, enacting these changes is part of Creative AI Lab's agenda.

3. CREATIVE AI LAB

Founded by Bunz and Jäger in 2019, the Creative AI Lab is a collaboration between the R&D Platform at Serpentine and King's College London's Department of Digital Humanities. The Lab serves as a site of inquiry into how best to facilitate, theorise and historicise ML practices, taking artistic research seriously as a contribution to knowledge creation and technical development. Conceived as a '"space of action"' (Crease 1993, p.106; quoted in: Spatz 2020, p.26) the Lab is thus both a research unit and an active site of curatorial experimentation. This approach acknowledges and enacts the necessity of theorising art practice not only as they are received at the front-end of artistic production by its audience, but also during the processes of research and development. In this way, the Lab aims to go beyond the study of artefacts to focus on the 'back-end' environments that have enabled their production.

The Lab's primary focus is on the ways in which artists are adapting and remaking AI processes, building their own datasets and reaching into the 'grey box' of AI technologies. These technical activities engage closely and critically with the technology itself, testing new approaches and challenging assumptions about the labour processes involved in, for example, labelling data or programming new tools. The Lab not only studies such work but also facilitates it through providing curatorial and technical production support to artists. With a focus on building the curatorial infrastructure within Serpentine, it works with artists on both the conceptual and technical side of R&D processes (Brouwer 2005; Ivanova & Vickers 2020). The aim is to enable the production of new prototypes for technical processes and an overview of tools (Arrigoni 2016), which could contribute to the creation of artworks as well as being deployed in other institutional contexts.

The Lab's mission is also to develop a critical literacy that can help art institutions approach AI technologies as advanced and multi-layered media. While reliant on the theoretical work needed to untangle issues such as the 'distributed authorship' (Ascott 2005) involved in artistic research, it also aims to communicate complex technical and philosophical ideas to audiences, ideas that are often left unaddressed in the prevailing curatorial approaches to ML/AI. At the same time, the Lab does not shy away from discussing the wider technical and socio-cultural issues that provide a context for AI art. Such critical pedagogic activities can have concrete outcomes, e.g. training audiences and institutions in how AI works, how

labour involved in AI-driven practice can be credited more fairly, but also foregrounding the processes, interfaces and the R&D work involved in the production of AI – activities that typically remain hidden or are given less valence. From the perspective of the Lab, art has a special role to play with regard to AI, as AI artworks 'train us in algorithmic understanding', as Nora Khan put it in her forthcoming book (Khan, forthcoming). To this end the Lab's goal is also to lobby for a shift towards a production and exhibition model that acknowledges collaborative effort in arts technology, and especially in AI art making – one that extends creative attribution to technical roles.

We are now at a stage when we are ready to launch a new phase of the Lab's work and outline some broader directions for research into creative AI.

4. WHITHER CREATIVE AI?

Drawing on the nexus of disciplines and fields of expertise -- from art and design through to art history, cultural theory, philosophy, cognitive science, computer science, and, last but not least, engineering, in both the conceptual and practical aspects of its agenda creative AI needs to explicitly embrace and articulate the open-ended orientation that characterises art practice. Given that art (and, indeed, any other cultural practice) is not produced in a vacuum, there is a need to balance technical expertise with socio-cultural engagement in any project whose aim is not just to research but also map out creative AI futures. With this, we are mindful of the poignant question raised by Safian Audry: 'How can [artists] work creatively and independently with a technology that has been aggressively privatised and is increasingly reliant on an industrial complex based on social media and advertising?' (Audry 2001, p.44). Such technology is not just used in advertising and entertainment industries; it also frequently serves as a technology of war: be it on the information front, as part of surveillance operations or as deployed in the construction of actual war machines, from drones through to planes and tanks.

Avoiding any simple binarisms evident in the moralistic-sounding 'AI for good', and any naive attempts to merely overcome a technological bias, we want to put an engaged critical reflection on the AI/ML technologies and their socio-cultural underpinnings as part of Creative AI's agenda. It is only through this approach that a more responsible position on designing the future of creative AI can be developed, we argue. This approach also involves building resources for artists who are curious to work with AI but who are yet to develop the skill set needed as well as for institutions interested in building the infrastructures that can support the production of creative AI works. The focus on the 'back-end' of AI art, pioneered by the Creative AI Lab, needs to be extended to the study of both technical and social environments. Repurposing the original 4C of the 'Command – Control – Communication – Computer', with its orientation towards mission accomplishment based on the cybernetic logic and its original military associations, we propose to adopt a 5C model for Creative AI that stands for 'Creative – Critical – Constructive – Collaborative – Computational'.

Drawing on the existing practices in collaborative art, open source and knowledge exchange, the 5C model supports an ethics of collaboration that involves building horizontal non-competitive alliances of institutions and stakeholders interested in creative AI: museums and galleries, universities and art schools, technology companies. The increasingly fragile funding landscape for the arts in many parts of the globe, whereby technology companies are the new art patrons, means that those companies are increasingly involved in setting the agenda for the creative field (Serpentine R&D 2020). This state of events, coupled with the requirement for extensive technological support and innovation, means that no single artist or institution can 'win' at creative AI. Like many other similar organisations, our Lab therefore has to negotiate how to work directly with industry in the new landscape of public-private partnerships in the name of 'innovation'.

With the 5C model we want to propose a move beyond any single-goal mode of thinking to support a sustainable alternative for an open-ended creative AI as a practice, a network of research and development spaces, and a set of concepts. In a recurrent manner adopted in the second-order cybernetics, this 5C model can itself in time become part of the practice of creative AI, seen as an attempt to build not just new artefacts or new technologies that support them, but also new ways of working, thinking and making AI, and making things with AI, collectively and collaboratively. While this proposal may sound utopian to some, the current global situation where the fragility of life – as evident in the climate crisis, the Covid pandemic or the reawakened threat of the nuclear war – has been put on display surely needs to remain open to any creative attempts to seek alternative models of making, working and living.

As part of this model, where the 'back-end' gets more attention than the artefact, a transformation of the idea of 'the artist' as a stand-alone genius, standing above, or aside from, the world, can (and perhaps should) be enacted. Today's artist, as argued by Tereza Stejskalová, needs to understand that 'she is not anyone special nor is she doing anything special but is, in principle, like any other social network user who makes manifest the (crisis

of) emotions, relations and labour which sustain life itself' (Stejskalová 2021, p.101). This recognition can shift the attention of creative AI work from individual accomplishments and solutions to the collaborative search for actions. In this respect, artistic research projects can offer blueprints for different configurations of aggregated human-machine intelligence, beyond the 'optimal' models which remain the goal of the technology industry (Vallor 2021). Art practice can thus serve as a space for the working out of alternative ethical metrics and values, beyond optimisation, efficiency or profit.

5. CONCLUSION: QUESTIONS FOR THE FUTURE

The 5C model for Creative AI that stands for 'Creative – Critical – Constructive – Collaborative – Computational' brings together technical research and conceptual inquiry, while shifting focus from artefacts to their wider contexts, processes and infrastructures. Encompassing an examination of creativity as a collaborative process between humans and machines, it also postulates the need for a culturally-driven reflection on the value of those collaborations and on their outcomes. Future areas for creative AI research emerging from this model include: (1) the reconfiguration of culture as a domain of not just human-made meanings but also machinic calculation; (2) challenges posed to computationalism by research on connectivist perspectives, including art's ability to test embodied models of AI and ML; (3) a shift from machine vision to machine perception as a mode of sensing the world with images and data; (4) the emergence of artificial consciousness as a creative artefact. Creative AI can thus serve as a space for exploring new connections and new alliances –- on both micro and macro, algorithmic and institutional level – but it can also, if need be, serve as a warning.

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Research on Creative Transformation of Excellent Traditional Chinese Culture: Taking interaction design of traditional handicraft culture translation as an example

Wei Yuan
Guangdong University of Technology
China
18571001203@163.com

Ji Yi
Guangdong University of Technology
China
jiyi001@hotmail.com

Liu Yutong
Guangdong University of Technology
China
seanc@interactdigitalarts.uk

Sean Clark
Guangdong University of Technology
China
seanc@interactdigitalarts.uk

The current mobile apps of traditional handicrafts fail to deeply explore the culture connotation and artistic features of traditional handicrafts, leading to the weakening of the artistic value of all levels of culture contents in the traditional handicrafts design, which is not conducive to the effective transmission of culture contents in the traditional handicrafts. Based on Malinowski's theory of "three factors in culture", this paper proposes to extract typical cultural elements from the material, behavioural and spiritual aspects of traditional handicraft, the different levels by direct translation, continuation of translation and indirect translation method for traditional handicraft class APP interaction interface, interaction design, interactive content to provide design elements, The generalised cultural content is transformed into design symbols with identifying characteristics, which can be applied to the interaction design of traditional handcraft mobile APP. The interaction design strategy is proposed to provide new design ideas and references for the interaction design of traditional handcraft mobile APP.

Traditional handicrafts. Cultural translation. Interaction design. Mobile APP.

1. INTRODUCTION

As the materialised remains of folk culture and spiritual culture, Chinese traditional handicraft plays an important role in Chinese history and culture. Domestic scholars have also made corresponding explanations for the fundamental content of the inheritance of Chinese traditional handicrafts. Pan Lusheng believes that traditional crafts are the treasure of design education, and it is necessary to pay attention to inheriting the specific and fundamental contents of traditional crafts such as traditional shapes, subject styles, material tools, and technique (Panlusheng 2018). However, with the rapid development of national economy and technology, some traditional cultural forms representing China's unique cultural values have gradually disappeared from people's view, and many traditional crafts, folk arts and folk skills are on the verge of disappearing, and the living environment is increasingly worry (Liuqiming 2015). The arrival of the mobile Internet era has brought an opportunity for the "activation" of Chinese handicrafts. Traditional handicrafts are diversified through the mobile Internet platform in the form of vivid, real and close to the life of the masse (Zhaofeng 2018). By downloading traditional handicraft APP, users can intuitively, vividly and interestingly understand and learn the cultural content of traditional handicraft. Everyone has the opportunity to participate in cultural innovation and inheritance. Mobile Internet platform provides a new cultural communication medium for the inheritance of traditional handicraft in the new era. In respect and reduction, on the basis

of the foundation of culture contents in the traditional handicrafts, how to improve the effectiveness of the traditional handicraft class APP culture contents dissemination, interest and artistic problems worthy to be discussed at the present, let the user feel the traditional handicraft culture content at the same, also can obtain smooth operation experience, and deep cultural connotation.

2. STATUS QUO AND EXISTING PROBLEMS OF TRADITIONAL HANDICRAFT APP

In recent years, a lot to spread traditional handicraft culture as the content and combining with digital media technology in the mobile terminal APP online, covering the cultural education, games, interactive, interest cultivation, and other fields, can make the traditional handicraft culture content in a more well form of the spread of public life scene, and accepted by the public. For example, a series of high-quality apps, such as Daily Palace Museum, Folding Fan and Mortise, are launched on the iOS APP platform, focusing on the inheritance of traditional handicrafts, folk arts and folk skills. For example, the Palace Museum APP introduces the cultural relics in the Palace Museum into the public life through daily presentation, effectively spreading the culture of the Palace Museum. Folding fan APP conveys the production process of folding fans to the public through interactive animation. Mortise and tenon joint of the shapes in the form of a 3d model to display in the app of Mortise and tenon, the user can be 360 degrees to observe the process structure of mortise and tenon joint, the APP is effective to a certain extent, the spread of the culture content of traditional arts and crafts, and interface screen beautifully smooth interaction experience, rich in content and interesting, also become each big APP store recommend high quality APP, It has been well received by the majority of users. At present, the innovative design of traditional handicrafts has quickly become a hot spot in the Internet industry. The use of mobile Internet platform to spread the cultural content of traditional handicrafts have greatly broken the transmission limit. The public can experience the cultural content of traditional handicrafts in more convenient and rich forms, and interact with the characters, stories and scenes in traditional culture.

Representative cases of highly used traditional handicraft apps with existing users in android APP store and iOS APP store were selected and analysed respectively. After investigation, it is found that many traditional handicraft categories only directly transfer the content and elements of traditional handicraft into the interface design, and rarely dig into the cultural connotation and characteristics of design objects, resulting in poor aesthetic quality and separation of function and form in interface design. Especially in the information architecture of interaction, there are tedious and unclear hierarchical problems, which greatly hinder the cognitive learning of users in the process of interaction, resulting in poor cognition and experience of users.

In the face of such situation, how to make use of the mobile Internet platform, realise the more traditional handicraft culture information, accurate, in-depth inheritance and transformation, make its cultural content and expression form unified, traditional handicraft culture content nature vividly into the APP design of each link, so as to achieve the best translation of traditional handicraft culture content, enhance the effectiveness, interest and artistry of cultural information dissemination in traditional handicraft APP, so that users can experience the deep cultural connotation and get smooth operation experience.

3. CULTURAL TRANSLATION OF TRADITIONAL HANDICRAFT IN THE CONTEXT OF MOBILE INTERNET

"Cultural translation" in the context of mobile Internet refers to the process of transmission and dissemination of traditional cultural information through Internet media, which includes the extraction and processing of visual elements such as patterns and patterns in traditional cultural information, the extraction and coding of user behaviour habits, and the sublimation of cultural spirit connotation (Wangjing 2016). The definition of "cultural translation" in this paper refers to the accurate and comprehensive interpretation of cultural information, and the process of information extraction, interpretation, translation, design, expression, reorganization and dissemination. The traditional handicraft culture information associated with the interaction design of mobile APP , make the interaction design as an important tool to translate traditional handicraft culture information, the generalization of the cultural information into design symbol recognition characteristics and applicable to traditional handicraft class APP interaction design, let the user feel the traditional handicraft culture content at the same time, You can also get a smooth operating experience and a deep cultural connotation.

4. CULTURAL TRANSLATION AND CONSTRUCTION ORIENTED TO TRADITIONAL HANDICRAFT

The theory of "three factors in culture" means that culture consists of three levels: the level of utensils, which indicates what kind of tools and utensils are used by the country and society to produce and

live; Organization layer represents how the society organises and gathers individuals to interact with production and life. The spiritual level, including the different values and behavioural selection standards of each society, is inseparable from the three levels, which together form an organic whole (Linyifu 2016).

This article is based on the concept of cultural translation theory of "three factors in culture", to inheriting the traditional arts and crafts tradition modelling, artistic features, craft techniques, materials, tools and other specific contents as the goal, respectively from implements, organization layer and spirit layer select a representative traditional handicraft culture elements as target design expression, transfer and application of direct translation, continue, indirect translation method, To achieve systematic interpretation, translation and dissemination of traditional handicraft cultural information (Hexuemei 2018).

Material level translation of traditional handicraft cultural contents based on artifacts layer: Utensils layer represents the dominant visual elements of traditional handicraft, such as patterns, utensils type, colour matching and other features that can convey traditional meaning. The public can understand the aesthetic value of traditional culture material layer superficially through visual language. Behavioural translation of traditional handicraft cultural contents based on the organizational layer: refers to the implicit behavioural elements of traditional handicraft, such as the transfer of traditional techniques, methods, processes and tools, etc., and spiritual translation of traditional handicraft cultural contents based on the spiritual layer: The spiritual level represents the philosophy, history and culture, customs and habits, myths and legends, and humanistic concepts inherited from traditional handicrafts. The spiritual level transmits the cultural connotation of traditional handicrafts to the public. The mapping between the two provides theoretical support for sorting out the translation levels of traditional handicrafts, as shown in Table 1.

The core of the translation of traditional handicraft cultural information is how to translate the representative cultural elements of material layer, behaviour layer and spirit layer into the interaction design of traditional handicraft APP in a real and natural way. The application methods of cultural translation can be divided into direct, continuous and indirect translation methods (Lizhirong 2018). Direct translation is to graphically process the representative and visible content in the material level of traditional handicrafts by simulating the appearance of objects, forming recognizable image symbols, which will be used as the visual carrier of interface design elements. Continuous translation is to express the information that is not highly visualised and requires certain association to be correlated. The production techniques, tools and processes of traditional handicrafts are continuously translated into the situational fit of interactive gestures, animation effects and operational feedback in APP interface. Indirect translation is used to express the strongly suggestive and completely invisible information, such as the philosophical thoughts of traditional handicrafts, religious beliefs, history and humanities, etc., by recessive correlation between invisible content and visual symbols, and then re-creation with objective things as the reference. It integrates its spiritual culture into visual images and indirectly translates the spiritual core of traditional handicrafts through concrete and multi-sensory interactive content. continuation and indirect translation directly by using the method of traditional arts and crafts representative cultural elements reasonable translation and different levels of applied to traditional handicraft APP interaction interface, interaction design, interactive content, thus its excellent traditional handicraft culture content, the real naturally translated into the interaction design of traditional handicraft APP. The interaction design framework of traditional handicraft APP based on cultural translation is shown in Figure 1

Table 1: *Translation of traditional handicraft cultural content based on "three factors in culture" in cultural translation*

Cultural level	**Concept definition**	**Translation of traditional handicraft culture**
Implements layer	What kind of tools does society use to live	It mainly shows the components of dominant visual elements, such as pattern, shape, colour value, colour matching and other material levels
Organization level	How does society organise individuals to interact with production and life	It mainly shows people's life scenes of production and active labour, such as techniques, methods, processes and tools
Spirit layer	Represents the different values, behaviour choices, etc., of each society	It mainly displays the philosophical ideas that have been inherited from traditional culture, such as history, humanity, customs and customs, and religious myths

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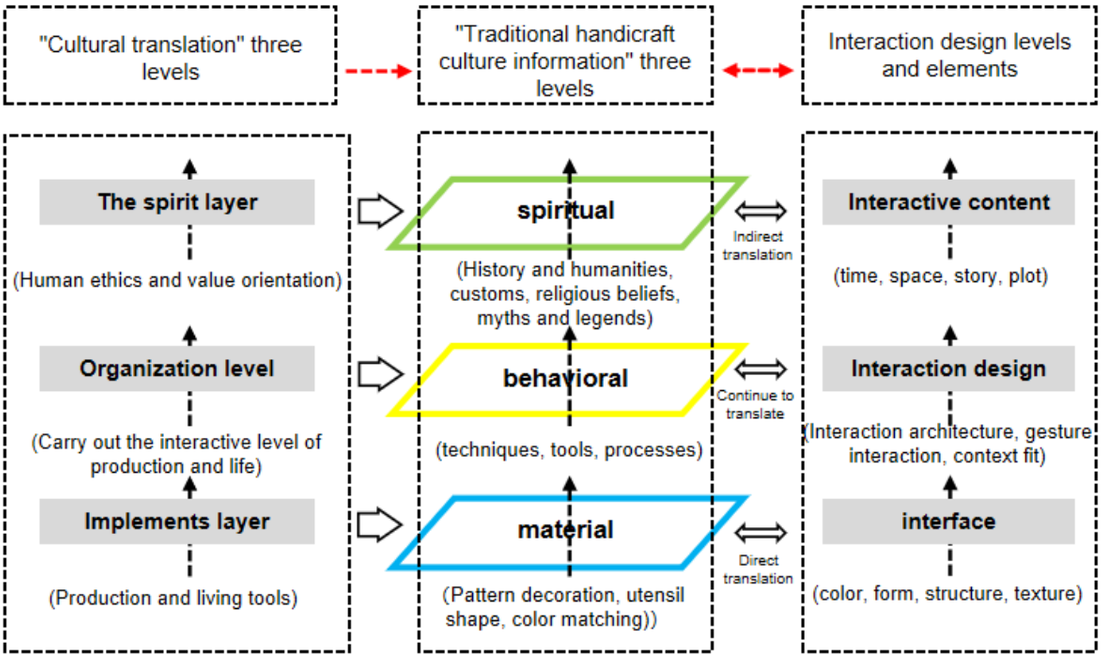

Figure 1: *Interaction design framework of traditional handicraft APP based on "Cultural three-factor theory" in cultural translation.*

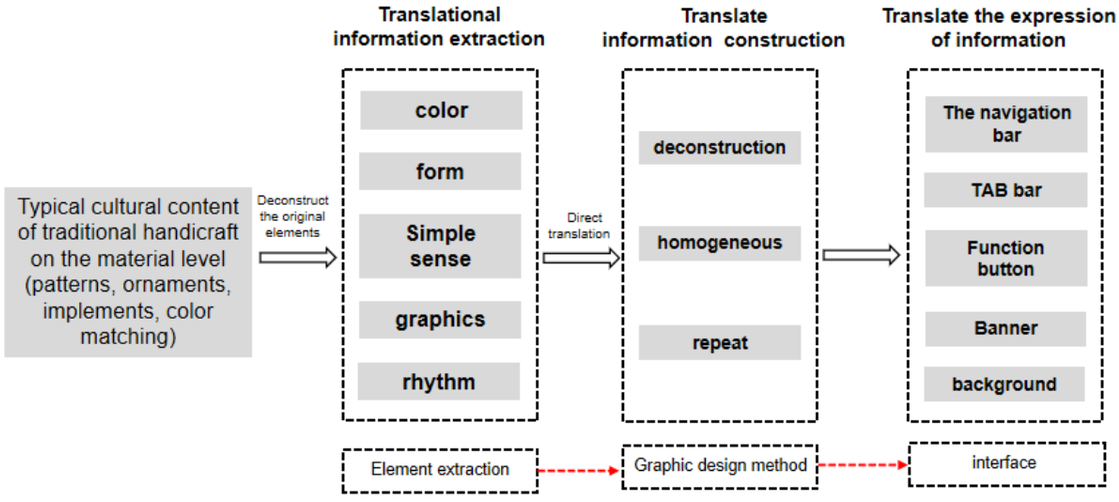

Figure 2: *The direct translation of the material aspect of traditional handicraft.*

5. INTERACTIVE DESIGN STRATEGY OF TRADITIONAL HANDICRAFT MOBILE APP BASED ON CULTURAL TRANSLATION

Direct translation of the material level of traditional handicraft: The cultural content of the material level of traditional handicraft is mainly composed of some explicit visual elements, such as decorative patterns, styles and forms, colour value matching and text symbols that can convey cultural meaning. When making traditional handicraft material directly translated, first of all, there are a lot from the culture content of extract the symbolic significance of typical cultural elements, to filter out the cultural elements in translation of information extraction and processing, for each of the elements of colour, composition, shape, texture, style and rhythm of abstract and concrete, static or dynamic elements extraction, After extraction, elements with similar characteristics are disassembled, and then graphic design methods such as deconstruction, isomorphism and repetition are used to construct new and identifiable image symbols (Wangweiwei 2018). These recognizable graphic symbols serve as visual vectors for interface design elements such as navigation bars, banners, TAB bars, functional buttons, and background images. In this process, the typical cultural symbols on the material level of traditional handicrafts are correlated with the controls on the APP interactive interface, so that the public can directly understand the aesthetic value on the material level of traditional handicrafts through the image symbols in the interface. The direct translation of the material aspects of traditional handicrafts is shown in Figure 2.

The main content of traditional handicraft behaviour is production technology, production tools and production process. The interaction design of mobile terminals focuses on the possible behavioural operations of users and how the product should cooperate with and respond to user behaviours (Haolibin 2015). At the behavioural level, cultural translation can use guidance and simulation methods to associate and transfer the behavioural habits generated by users in the process of understanding traditional handicrafts and translate them into interactive gestures, animation effects and operational feedback in the APP interface. Combined with the process production situation and the tools needed, observe people's behaviour and habit of using tools in daily life, transform the design into interface interactive operation and interface feedback, control various professional tools through interactive operation, guide users to complete the whole production process. In interface interaction design, users' natural behaviour habits and applications are extended and translated to bring users a natural and smooth operation experience. Achieve the purpose of improving product consistency, ease of use and learnability. The continuous translation of traditional handicraft behaviour is shown in Figure 3.

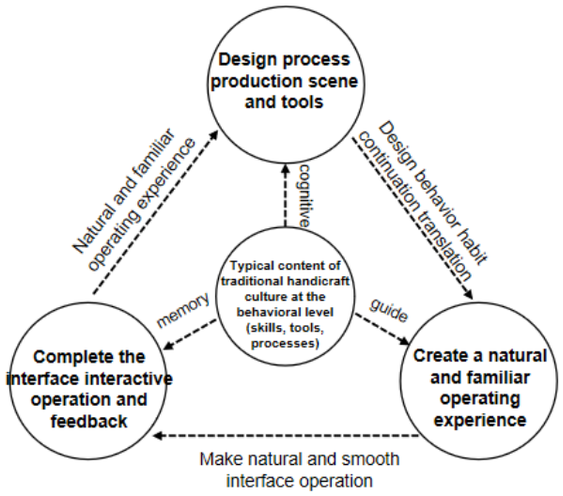

Figure 3: *Interactive interface design of behavioural information of Canton glazed porcelain APP.*

Indirect translation of the spirit of traditional handicraft: The main content of the spirit of traditional handicraft is the history and humanities, customs and habits, myths and legends, humanistic ideas and so on, which are usually immaterial, abstract, implicit and introverted. The public needs to feel its spiritual core through experience and association. Indirect translation in traditional handicraft spirit, first to deal with the main content of the traditional craft of spiritual information extraction, choose the most representative and conforms to the culture spirit of traditional handicraft of subjectivity, because of the culture spirit of traditional handicraft is usually representational and hidden, so will non-figurative cultural spirit recessive associated with visual symbols, And objective things as a secondary reference for creation, and then through the use of narrative design to generate interactive scenes, with space, time, light, sound and other sensory experience interaction effects, enhance the public experience into a multi-sensory visual interactive environment, convey the spiritual core of traditional handicrafts. At the same time, the interaction interface and interaction design level also affect the user's perception and interaction with the spiritual level. The indirect translation of traditional handicraft spirit is shown in Figure 4.

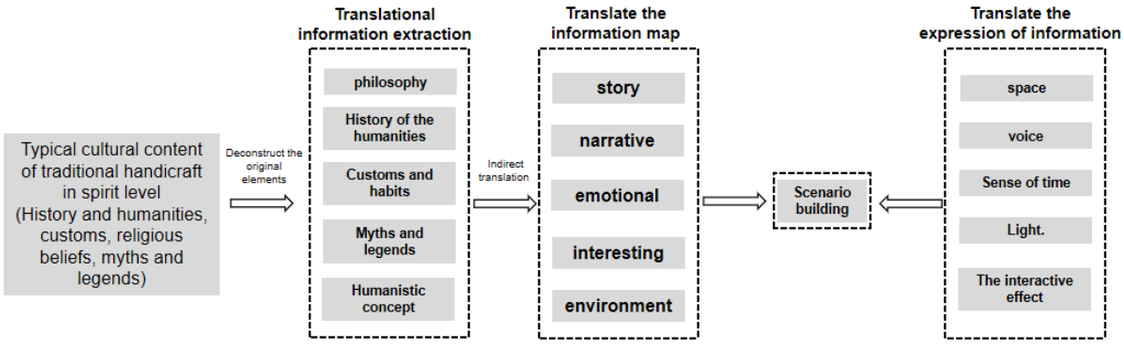

Figure 4: A continuation of the behavioural translation of traditional handicrafts.

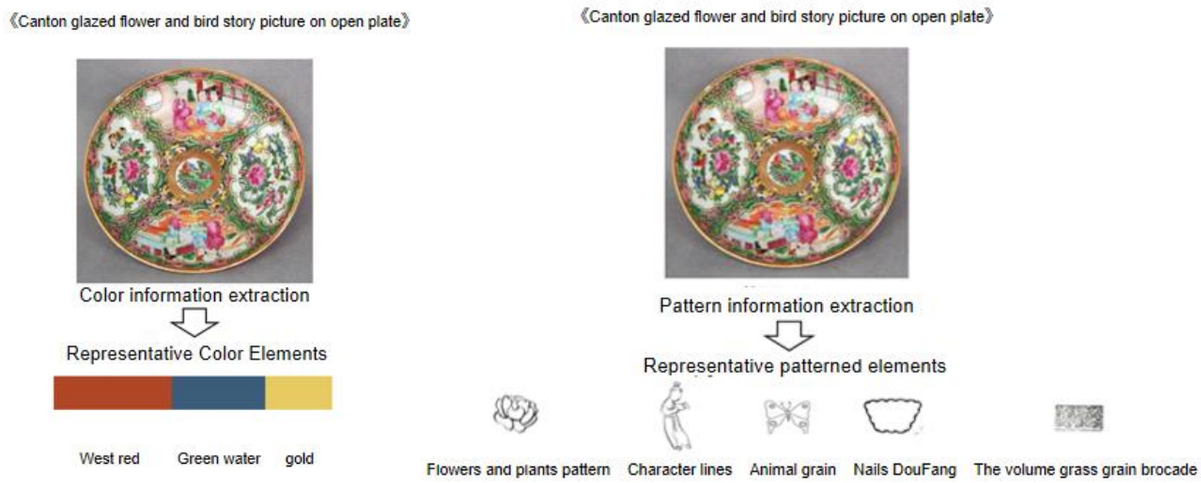

Figure 5: *Extraction and construction of Canton glazed porcelain visual information.*

Figure 6: *Interactive interface design on the material level of Canton glazed porcelain APP.*

6. DESIGN PRACTICE OF TRADITIONAL HANDICRAFT APP BASED ON CULTURAL TRANSLATION -- TAKING CANTON GLAZED PORCELAIN APP AS AN EXAMPLE

Canton glazed porcelain is a kind of coloured porcelain handicraft with strong Oriental characteristics produced in Guangzhou, China. Its firing technique is the representative of glaze painting, which has important cultural and historical research value. Taking Canton glazed porcelain as an example, based on cultural translation and combined with the design principles of APP, this study proposes the design strategies in the interactive interface, interactive content and interactive design of traditional handicrafts APP and carries out interface interactive design to improve the effectiveness, interest and artistry of cultural information dissemination of traditional handicrafts APP. Improve the user experience of traditional handicraft apps.

Direct translation of Canton Glazed Porcelain APP on material Layer: On the material level of mobile APP, the author studied the characteristics of representative visual elements such as patterns and ornaments, object types, colour value and colour matching on the material level of Canton glazed porcelain through in-depth research and analysis of a large number of objects and pictures. Selecting typical images, sorting, analysis, to select the sample pattern, colour, rhythm, and the composition characteristics of direct extraction, obtain colours, patterns, composition and rhythm elements extraction. Extracted out wide colour porcelain features and fancy design through the deconstruction, isomorphism and design method of repeated design combined with modern elements. It is also applied to interactive controls, label bars, navigation bars, lists, etc., so that the typical image symbols of traditional handicrafts are correlated with the interactive interface controls of APP. The public can directly understand the aesthetic value of traditional handicrafts through the image symbols in the interface (Liuxu 2020). Visual information extraction diagram is shown in Figure 5
In the design practice of APP at the material level, the representative golden colour and aqua blue colour of Canton glazed porcelain are extracted as the theme colour to establish the overall colour tone of APP. The characteristic patterns and fancy features of Canton glazed porcelain are extracted, and the design is developed with modern elements, which are applied to interactive controls and background decoration. The function keys on the main page are distributed in drawer style, simplified in form, so that the overall style is unified, and the local font highlights the traditional form with vertical version. The main interface mainly displays the artistic features of Canton glazed porcelain, and directly translates the material knowledge content of Canton glazed porcelain, such as modelling styles, patterns and themes, through text information, 3D models and knowledge cards. The physical interface design is shown in Figure 6.

Continuing translation of the behavioural dimension of the Canton glazed porcelain app: In the behavioural level of mobile APP, it is convenient for users to have a clearer understanding of the firing techniques and tools of Canton glazed porcelain. The author through to the traditional handicraft content, mainly by the skills, tools, procedures and so on in-depth research and analysis. The main content of the process is disassembled, and then the association and simulation are carried out according to the tools required for each step and the user's cognition and operation habits of the tools, so as to match the corresponding interactive gestures, animation effects and operation feedback. Corresponds to the situation of the production process and the required tools, by understanding the behaviour of the people to use tools in daily life to deduce to interface interaction and interface design of feedback operation, guide the user through the "click", "sliding", "drag" and other attempts to operate a variety of professional tools to complete the whole process of Canton enamel porcelain production, Through the continuous translation of APP's behaviour level, the interactive experience between users and mobile applications is strengthened to bring users a natural and smooth operation experience, so as to achieve the goal of improving product consistency, ease of use and learnability. Behaviour information extraction and construction are shown in Table 2.

Table 2: *Extraction and construction of interactive behaviour information of Canton glazed porcelain.*

The process flow	Draft plans	Choose fetal porcelain	Mixed pigment	Coloured drawing or pattern	Pack oven
Contents summary	Design the whole composition and complete the preliminary drawing	Choose glazed smooth, not yellow, not black, not deformation, can sit porcelain tire, after the selection of the need to be cleaned	Pour all the pigment powder into the bowl, first use the mallet to dry trace the powder, then add water and glue to the mallet according to the properties of the pigments, then use the bamboo spatula to mix the pigments to the appropriate concentration	(1) opening, turning line, ring. The first step of the painting is to open, that is, in accordance with the design pattern will be roughly determined composition (2) write porcelain black. Use porcelain black to paint various patterns on a well-opened porcelain mould (3) color filling. Colour the painted porcelain mould. (4) province noodles, tart flowers. Paint feathers, petals, etc in porcelain black on an already colored pattern (5) Fill in green. On the lustful porcelain tire, you still need to fill in the blank space (6) edge sealing, bucket color. It is the last working procedure, go up in implement brim BESMEAR namely aureate, be in implement again, ear place picture on grain act the role of or gold color	Furnace. Put the large and thick pieces on the bottom of the stove and the small and thin ones on top. After entering the kiln, the temperature should be gradually heated, and the temperature in the kiln should be kept uniform to avoid sudden cooling and sudden heating and uneven heating. After 5-6 hours, the temperature in the kiln will almost reach 700℃. When the temperature in the kiln reaches 700℃, it is necessary to slowly reduce the temperature and let the kiln cool down. After burning, wait for 3 hours before opening the furnace cover
Tools required Pape	Tools required Paper, Drawing Brush	Porcelaintire Pigment Powder	Trapping Bowl, Color Hammer, Water, Glue, Bamboo Shovel, Vegetable Oil, Porcelaintire,	Porcelaintire, Ink Meter, Ink Stripe, Drawing Brush	Pigment Baking Ove, Porcelaintire, Thermometer
Behavioral information extraction	On the paper with the outline brush for composition, complete the first draft of the design	In many different characteristics of porcelain tire, select the best porcelain tire to make	Pour the pigment powder into the bowl, add water and glue, and use the color mallet to fuse, and finally add the appropriate amount of vegetable oil and use bamboo spatula to adjust to a steady concentration	According to the design pattern, the ink meter and ink strip are used to determine the general composition and draw the edges on the porcelain body. The drawing brush is dipped into the porcelain black to describe the patterns. After the completion, the color is filled in and the edges are drawn, and the edges are sealed finally	Put the porcelain tire into the oven and watch the thermometer to control the temperature
Behavioral information construction	1. Select the drawing pen 2. Move the pen to the paper	1. Check the characteristics of porcelain tires 2. Judge the quality of porcelain tires 3.Choosing porcelain body	1. Select pigment powder 2. Pour it into a bowl 3. Add water and glue 4. Add vegetable oil. 5. Use bamboo spatula to adjust the consistency	1. Select the design pattern 2. Select the ink meter to describe the edge line 3. Apply gold paint to the edges of the objects and the ears	1. Select the painted porcelain tire 2. Put it in the baking oven
Interaction gestures	Touch click, move	Swipe, touch and click, hold and select	Touch click, select Move, Squeeze, Rotate	Touch click, hold select, select move, slide, rotate	Touch click, select Move, Squeeze, Rotate

Figure 7: *Interactive interface design of behavioural information of Canton glazed porcelain APP.*

Figure 8: *Interactive interface design of behavioural information of Canton glazed porcelain APP.*

In the behavioural design practice of APP, an interactive learning environment is constructed by integrating Canton glazed porcelain firing techniques, tools and process through animation effects, production tools, interactive gestures, operational feedback and sound effects. Users can experience the implicit connotation of Canton glazed porcelain production process through the embodied way of interactive behaviour. The interface design of interactive behaviour information is shown in Figure 7.

Indirect translation on the spiritual Aspect of Canton Glazed Porcelain APP: Canton enamel history origin, is not only the economic and trade exchanges of Chinese and western material entity, also the embodiment of the exchanges between Chinese and western culture spirit image, its historical humanities is the most representative and conforms to the traditional handicraft culture spirit of subjectivity, through choosing Canton enamel porcelain of typical artistic characteristics of each historical periods as well as the exquisite historical background to translate information extraction, The abstract visual representations of the content, and the objective things as a reference for creating again, finally, in the form of story, interest, emotion story building, with sound and light, animation, interactive rendering, strengthen public experience into the feeling, let users through musical background to understand the history of Canton enamel in the plot, Understand the craftsman's spirit that Canton glazed porcelain conveys. In the design practice of APP at the spiritual level, visual presentation of APP interactive content should be strengthened to make it have strong guidance and enhance the sense of integration in public experience. The spiritual connotation of Canton glazed porcelain is indirectly translated through narrative knowledge animation, and the process of historical events is described and demonstrated through each frame of image by using the characteristics of knowledge animation. The effect is realistic, reductive, narratable, temporal and procedural, which effectively reduces the cognitive load of users and enhances the natural interactive experience. Users can understand the artistic characteristics and cultural value of Canton glazed porcelain and the craftsman spirit to be conveyed through the story with vivid emotion. The interface design of cultural information is shown in Figure 8.

In addition, the research also carried out prototype testing, and applied the traditional handicraft APP interaction model and design strategy constructed by cultural translation theory to the APP design practice of Canton glazed porcelain mobile terminal, and gained certain praise in terms of usability. This laid the foundation for further research.

As China increasingly attaches importance to the inheritance and protection of intangible cultural heritage, traditional handicraft APPS, as an important medium for inheritance, play an important role. This study is based on cultural translation theory of "three factors in culture" (Linyifu 2016), put forward from the traditional handicraft material level, behaviour level and spiritual level, methods of extracting typical cultural content elements on different levels by direct translation, continuation of translation and indirect translation method for traditional handicraft class APP interaction interface, interaction design, interactive content to provide design elements (Lizhirong 2018),The interactive design framework of a new traditional handicraft APP is constructed, and Canton glazed porcelain is taken as an example for design practice. It is hoped that this research project can provide an innovative model with practical value for Canton glazed porcelain, which is in the bottleneck of development. The proposed research on the interaction model of mobile APP of traditional handicraft can provide a valuable reference for the inheritance, research and development of traditional handicraft. In this way, the effectiveness, interest and artistry of the cultural information dissemination of traditional handicraft APP can be improved, so that users can experience the cultural content of traditional handicraft and get smooth operation experience and profound cultural connotation, so as to enhance the enthusiasm of people to participate in traditional handicraft and promote the dissemination of Traditional Chinese culture.

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Female Self-presentation through Online Dating Applications

Jing Li
Department of Sociology
University of York
York, UK
&
Jing'an District
Shanghai, China
jl3692@york.ac.uk
lj243898473@126.com

Jonathan P. Bowen
School of Engineering
London South Bank University
London, UK
&
Southwest University
Chongqing, China
jonathan.bowen@lsbu.ac.uk
http://www.jpbowen.com

Online self-presentation plays a vital role in online dating applications due to online filtering and contacting the desirable potential partners through presentational clues. Applying qualitative data collected from young female participants and the theoretical *Two-Component Model* of Leary & Kowalski (1990) on the motivation process and construction process, this paper presents an overview of a study based on the comprehension of participants' motivation process for dating profiles to explore the construction process of online dating self-presentational approaches. The results indicate that through the self-presentational clues of photography, text, and video display for constructing online dating profiles, young women can selectively and strategically demonstrate the partial and ornamental self with physical and ideological attractiveness. Simultaneously, they struggle with their ideal and real self in the process of online dating self-presentation.

Digital culture. Gender studies. Online dating. Online self-presentation.

1. BACKGROUND

> "Women […] are most difficult to nurture. If one is close to them, they lose their reserve, while if one is distant, they feel resentful."
> – Confucius (551–479 BCE)

Figure 1: *Parents at the Shanghai marriage market. (Photograph by Jonathan Bowen, 2013.)*

Traditionally marriage has been arranged by parents; witness the weekly Shanghai marriage market that continues until recent times, with only parents present (see Figure 1). However online mobile access has enabled young people to connect much more easily and directly, without parental intervention or even knowledge (e.g., see Figure 2).

Figure 2: *A young Shanghai couple on their mobile phones. (Photograph by Jonathan Bowen, 2013.)*

Connecting online has been a motivation for individuals and organisations since the technology of the internet has made this possible (Bowen 1999). Digital culture has become increasingly important in recent years with the wide online access through mobile devices (Giannini & Bowen 2019a). Digital and real life have become more and more blurred with the progress of time (Bowen & Giannini 2014; 2021). There are some gender differences with respect to preferences for online presentation

(Boiano 2008). The concept of beauty can be enhanced and idealised using digital technology (Wiedemann 2001). More recently, online communities and interaction through social media have become important, including acting as a "digital citizen", engaging in societal issues (Borda & Bowen 2021). For example, the #MeToo activist movement has been a worldwide phenomenon from the United States (Giannini 2019) to China (Han 2019).

Self-presentation is the process of conveying information about yourself (or one's image) to other people. The presentation may be meant to match: 1) one's own self-image; 2) an audience's expectations or preferences (Baumeister & Hutton 1987). This has become much easier with respect to individuals and a potentially worldwide audience with the ever more interconnected infrastructure online. This may be for professional or personal reasons. In this paper, we explore the self-presentation of females with respect to online dating.

Nowadays, online dating which has been described as a process of "encountering potential partners through online profiles" (Finkel et al. 2012, p.3), has become a widely accepted method for individuals to meet potential partners. According to Rosenfeld et al. (2019), online dating has dramatically subverted the pattern of seeking and establishing courtship and relationships. In other words, most online daters will filter and online contact their preferable potential partners through the self-presentational clues of photographs, textual description, and video display; they will use these for the construction of their online dating profiles and potential daters are expected to review these before meeting. Thus, online self-presentation plays a vital role in the online dating environment.

Scholars have been interested in the role of online self-presentation in physical attractiveness and relationship initiation due in part to physical attractiveness being a crucial parameter in dating circumstances. Additionally, since physical attractiveness is regarded as a kind of premium in the field of mate selection, daters may manipulate dating information related to physical attractiveness in the process of online self-presentation to increase their level of visual perception involved in physical attractiveness (Hancock & Toma 2009). As well as creating an impression of the desired self through strategic and selective self-presentation, packaging, beautification and editing in social interactions (Leary 1996). This may be the reason why an essential motivation in the process of constructing an online dating profile for individuals is to shape their social presence and gender attraction through exquisite text descriptions, embellished photo-graphs, and edited videos.

The research outlined in this paper focuses on exploring the self-presentation of young women through profiles on online dating applications. The overall presentation is based on Li (2021) and covers:

- Gender differences in self-presentation, briefly explaining the different manifestations of gender in online self-presentation and the reason that the description of online representation and gender is relevant in relation to online dating.
- The aims that drove the exploration of this topic and a statement of the research problem.
- The approach to the research methodology design.
- An analysis of the detailed results in Li (2021) and conclusions.

2. GENDER DIFFERENCES IN SELF-PRESENTATION

"Gender consists of the meanings ascribed to male and female social categories within a culture" (Cifre et al. 2018, p.2). Therefore, the "penetration" and integration of culture in people's psychology is crucial for the formation of people's societal gender identity (Wood & Eagly 2015). The thought and behaviour patterns of individuals and interactive communication may originate from their self-recognition of "culturally feminine and masculine meanings attached to men and women" (Wood & Eagly 2012, p. 461). In fact, much is known about gender differences in disclosure patterns between men and women (Dolgin & Minowa 1997).

For instance, since the motivations and benefits of height and weight are driven by gender schemas in online dating self-presentation, for the purpose of portraying themselves more physical attractive to the opposite sex, both male and female daters may make numerical adjustments to their actual dimensions of weight and height that are conducive to increasing their attractiveness (Toma et al. 2008). Further research indicated that gender differences in self-presentation have indicated that compared with men, women pay more attention to creating affirmative self-images (Haferkamp et al. 2012). In general, seductive individuals are typically identified as more ideal potential partners for dating (Gangestad & Scheyd 2005). Physical attractive-ness was regarded as the exclusive crucial characteristic that can predict whether a dater still has a desire to meet the partner again (Thornhill & Grammer 1999).

According to the supplemental analysis of Meltzer et al. (2014, p.1), physical attractiveness will not only affect the judgment criteria for mutual selection of "speed-dating paradigms" daters, but also has "implications for long-term relationships". Eastwick &

Finkel (2008) also report that in the dimension of choosing a long-term relationship partner, male daters tend to pay more attention to the physical attractiveness of appearance than females. This may be the reason why women prefer to elaborately select exquisite photography to enhance their dating profile online according to male norms in the online dating environment. Additionally, because of women's strategy for establishing online communication relationships, in the process of constructing online dating profiles, young women prefer to apply soft and approachable vocabulary for the description of their personality.

In terms of linguistic strategy, males are more inclined to use power and status-oriented linguistic strategies, while females typically apply subordinate communication skills and strategies (Carli & Bukatko 2000). Hence, for young women using online dating applications, the criterion of sophistication in establishing an online profile may be completely disparate from that of male counterparts as gender pattern influences and reflects different identity and self-presentation concerns (Manago et al. 2008). In addition, it is worth noting that although online and offline self-presentation vary in form of information disclosure, according to authors such as Magnuson and Dundes (2008), gender differences do not seem to be influenced by delivery media and platforms in the process of self-presentation, which means that both men and women conform to the traditional masculinity and femininity norms.

The research aimed to investigate the self-presentation of young women through their profiles on online dating applications. It commenced by focusing on online dating, online self-presentation, and online dating profiles. A motivation for research on this topic was the widespread social phenomenon of "leftover women" in China; Much of Chinese society "devalues unmarried women in their mid to late twenties because of their so-called 'leftover' status" (Liu 2017, p.41). Under pressure to match and choose relationships, the number of single young women, who are motivated to date online through self-presentation and initiative is on the rise. However, the percentage of young women who absorb long-term romantic relationships is pessimistic, especially for young women with higher education in large cities.

According to You et al. (2016), education level seems to be inversely proportional to young women's willingness to marry. University education is reported to reduce the likelihood of marriage by around 2.9% to 3.6%, while holding a postgraduate degree further reduces it by 8.4% to 10.4% (You et al. 2016). Therefore, how these young women seek romantic relationships through the self-presentational clues of profiles in online dating applications in the contradictions and interweaving of physical and ideological attractiveness, ideal and real self has become a very meaningful research topic.

3. RESEARCH AIMS

Through semi-structured interviews where they elaborate how they represent themselves on online dating applications, issues about this research orientation are also considered, such as:

- How do young women understand the self-presentational profile of online dating applications? What and how do young women think in the process of constructing online dating profiles?
- What specific experiences have influenced and changed their perception and evaluation of online dating profiles?

According to their responses to the interview questions (Li 2021, Appendix 4), the construction of online dating profiles through means such as textual description, photographs, and videos, can be a diversified way for young women to present themselves. The research aims were:

- To comprehend how young women understand their static self-presentational profiles in online dating applications, including:
- To understand physical attractiveness in online dating.
- Aggregation of understanding selective and strategic presentation of self through the profiles of online dating.
- To analyse how young women represent themselves through profiles on online dating applications, including:
    - Analysing how young women apply profile clues such as pictures, text, and video features, to demonstrate their self-presentational dating portfolios.
    - Investigating how young women construct self-presentational portfolios with clues of profiles.

The specific research questions were:

- How do young women comprehend their static self-presentational profiles in online dating applications?
- How do young women represent themselves through profiles on online dating applications?

Table 1: *The six-phase process of Braun & Clarke (2006) for conducting a Thematic Analysis, employed in this research.*

Phase	Explanation
Familiarising	At this stage, in addition to repeatedly listening to the recording, the manual recording of the interview that has just ended is extremely valuable, because the actual circumstances of the interview at this moment is unambiguous and quite approximate to the authenticity of the data itself (e.g., the participant tone). Then "reading and re-reading the data, noting down initial ideas" (Braun & Clarke 2006, p.87).
Generating initial codes	At this stage, the code for the entire data set was formulated according to the research question and interview schedule, looking for codes related to the specific question asked in the interview data. Attention was paid to the "interesting features of the data in a systematic fashion" (Braun & Clarke 2006, p.87), which were potential data for defining themes.
Searching for themes	The process of searching for themes was similar to advancements of preliminary data codes, abounding explanations, concepts, and areas of interest. This phase was to further establish the correlation between data and research questions.
Review of themes	During the review phase, the "thematic map" (Braun & Clarke 2006, p.87) model (see Figure 1) was applied primarily, which was a convenient way to visualise the themes that were found and start to think about how they relate to other themes.
Defining and naming themes	At this phase, in addition to defining insightful subject items in the "thematic map" (Braun & Clarke 2006, p.87), it is quite necessary to elaborate the rationale and essence, and link back to the theoretical construction of literature review.
Producing a report	During report generation, the participants transcribed and translated content was selected to interpret and validate the defined themes. These aspects are reported on in detail in Li (2021, chapter 3).

4. RESEARCH METHODOLOGY

To address the research questions, qualitative research was conducted in this study. Through using qualitative methods, this research aims to comprehend how young women understand their static self-presentational profiles in online dating applications. On this basis, the in-depth analysis on how young women represent themselves through profiles on online dating applications was explored. The study implemented semi-structured interviews, with 15 questions focused on exploring the self-presentations of young women through the narrative of profile construction on online dating applications, to collect data. Because while providing reliable, comparable data in the qualitative research, semi-structured interviews have reasonable and objective advantages, while still allowing researchers to interpret and investigate the opinions of respondents from different perspectives to comprehend the deep logic of the data thoroughly (Borg and Gall,1983). Several specific issues were addressed in the semi-structured interviews, such as the self-presentational profile of online dating, how to demonstrate your static self-revealing portfolios with the clues of photographs, textual descriptions and video display in online dating, and the self-struggle between the ideal and real.

Adopting the method of *Thematic Analysis* (Braun & Clarke 2006), the study reported here has elaborated on:

1. online dating profiles as carriers of "who am I?";
2. the self-presentational clues of physical attractiveness and ideological attractiveness being different in constructing profiles;
3. video in profiles bringing more multi-dimensional experience and rich dynamic perception transmission properties in personality shaping and self-presentation;
4. conflict-in the self-struggle between the ideal and real.

Table 1 above outlines the phases of the approach used in this research. Figure 3 overleaf shows the overall structure of the data analysis.

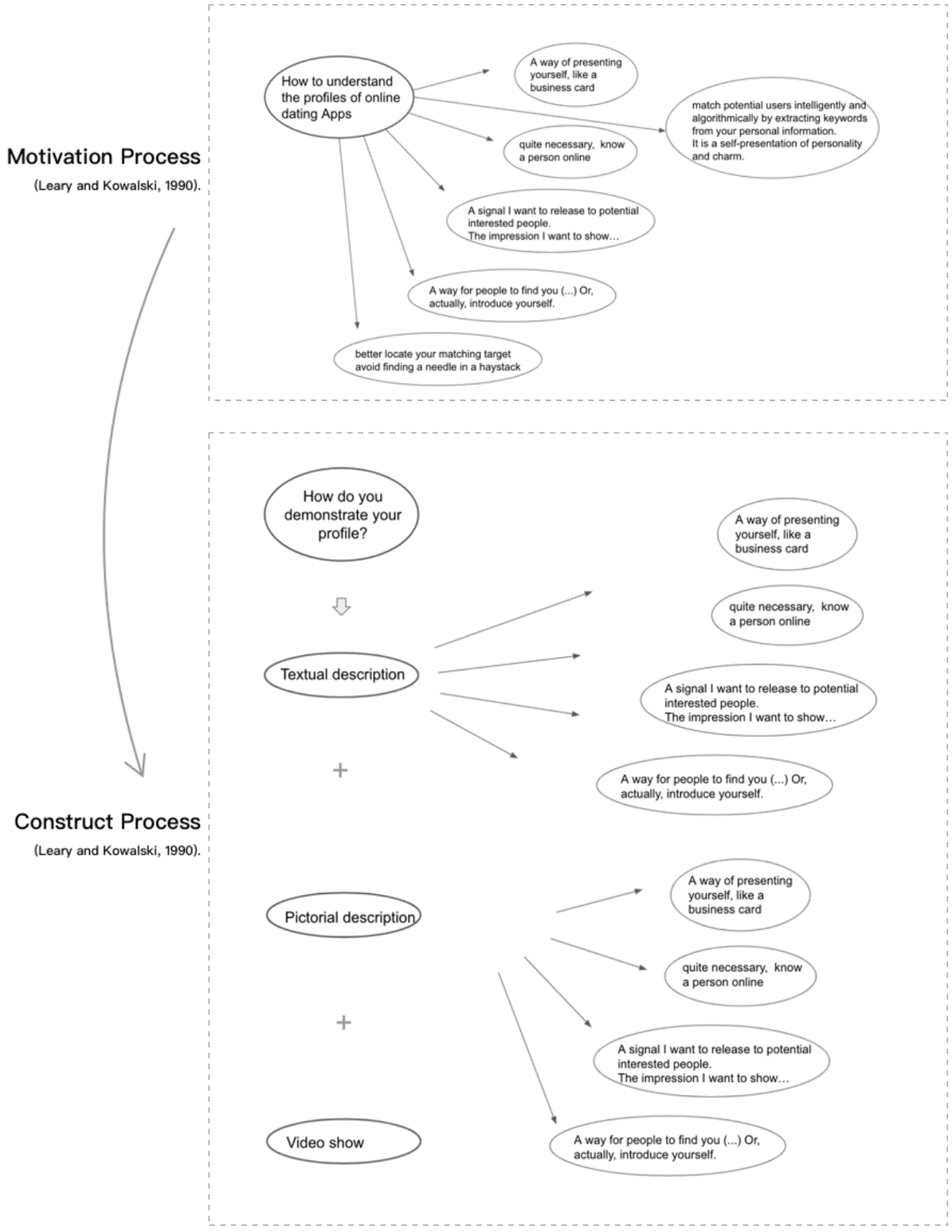

Figure 3: *The "Thematic map" (Braun & Clarke 2006, p.87) of the overall structural layout of data analysis. The overall structural layout of this study is based on the theoretical Two-Component Model of Leary & Kowalski (1990) of motivation process and construction process. Based on in-depth comprehension of the participants' motivation process for dating profiles, this process was used to conduct in-depth analysis and elaborate on their profile construction process.*

5. ANALYSIS OF RESULTS

Using qualitative research methods, this study conducted 11 in-depth semi-structured interviews with young women, investigating how they self-present themselves through their profiles of online dating applications. The participants were from Canada, China, UK, and USA. Apps used included CoffeeMeetsBagel, MOMO, Soul, Tantan, Tinder, and Zhengaiwang. Detailed information on the data obtained is available in Li (2021).

Specifically, guided by the self-presentational theoretical framework of the *Two-Component Model* of Leary & Kowalski (1990), based on in-depth analysis of how young women comprehend their static self-presentational profiles constructed through online self-presentation cues in online dating applications (Ellison et al. 2011), the research explored how young women driven by their self-representation motivation look to achieve the purpose of charmful presentation or attract potential dating partners through selectively and strategically presenting textual, pictorial, and video self-representational cues within the profiles of online dating. In the process of the narrative, these female participants not only elaborated on the cognition and positioning of themselves in the online dating environment, however they also comprehend the significance of the self-display carrier role of online dating profiles. This is, online dating profiles are carriers of “who am I?”.

Three of the participants believe that their aims of self-presentation are seeking soulmates. Four of the participants also mentioned soul mates frequently in interviews. Thus, different from previous literature on the dimensions of physical attractiveness, during the narrative and thinking process of self-presentation, they pay more attention to the disclosure of attraction signals such as the fit of thinking pattern and knowledge structure. However, in the process of interviews, they mentioned they also pay attention to the self-display effect of their attractive appearance in online dating profiles. The struggle of their online dating self-presentational behaviour is that it seems to portray superficial behaviour if potential daters are attracted by their physical appearance.

Furthermore, four of the participants elaborated that they showed their external and physical attractiveness in photos on their profiles according to the male norms in the online dating environment. Young female participants seemed to consider that the pictorial decoration of self-presentation through profiles would immediately impact their attractiveness to potential partners. Based on the self-representational inner motivation process (Leary & Kowalski 1990), the methods they used to construct their online dating profiles mainly revolved around beautifying and decorating their self-representation through diversified photos or selfies. Specifically, they selectively and strategically self-present photographs of their attractive bodies and likeable facial features to cater to male aesthetics. Thus, are women the charm of physical attraction or the charm of thought in the process of self-exhibition in online dating environments? This might be an interesting topic that is worth continuing to explore more deeply in the future.

In addition, regardless of the pursuit of physical attractiveness or ideological charm, they all seem to have experienced the struggle to achieve a balance between their real and ideal selves in the process of elaborating their self-presentation and returning to the inquiry that philosophers have been struggling with for a long time, who am I? Here, this issue may imply young women’s thinking on how to construct their dating identity in an online dating environment. Besides, among the 11 participants, only two younger participants made it clear that they were not looking for long-term relationships at the time of the interviews, and the remaining participants expressed the desire to establish long-term relationships.

However, according to their explanation, online dating applications like Tinder, Tantan, and MOMO are not their ideal dating platform for finding long-term relationships, because they believe that these platforms are full of individuals looking for boring hit-ups or sexual hook-ups. They prefer platforms with strict profile review to find serious long-term relationships. This consideration is a typically critical factor in studying how young women present themselves. This is because their attitude and inner motivation towards the platform determines the way they construct their profiles for online dating to present themselves.

Limitations

The limitations of this study are mainly manifested in sample recruitment. In this project, all 11 participants were acquaintances and friends of the researcher who were recruited through convenience sampling. This is even though the methodological aspect of the research setup included two sampling strategies, namely convenience sampling and snowball sampling (Emerson 2015). It was desirable to use two sampling strategies because every sample technology has space for improvement in the population dimension, and researchers can only compensate for these limitations through using a variety of sampling techniques superimposed on each other. However, due to the actual situation, snowball sampling did not yield the corresponding participants; hence, convenience sampling was the only one used, and it has limitations. In fact, the rationale behind most researchers’ application of

convenience sampling techniques is to acquiesce in the limitations of actual implementation (Etikan et al. 2016). Aware of the possibility of this limitation in advance, the implemented approach aimed to discuss the topic of this project from a professional and academic perspective in the interviewing process and attempted to conduct in-depth analysis and discussion from the perspective of the participants to obtain ponderable qualitative data. Hence, this project gathered enough interesting real analysis data and saturation in terms of data. However, the uniqueness of the sample is still an unavoidable problem. Although they are highly relevant to the research questions as participants, the lack of diversity and representation in terms of cultural background, educational background and personal experience may be the limitation. For example, young women with large discrepant educational attainment may have very different perspectives on how to show themselves in online dating. However, the data in this area cannot be traced and verified in detail based on the currently obtained data.

6. CONCLUSION

> "Women hold up half the sky."
> – Mao Zedong (1893–1976)

China remains a patriarchal male-dominated society in the real world, especially at the upper echelons (Phillips 2017). Witness the case of Peng Shuai and the varying responses around the world (Yu 2021). However, with respect to online dating, there is more of a level playing field, as illustrated by the survey in this paper.

This study advances comprehension of the thought processes and modes of online self-presentation of young women through online dating profiles. In addition, the findings of this research indicate that online self-presentation plays a vital role in online dating applications. Through the self-presentational clues in their online dating profiles, young women selectively and strategically demonstrate the partial and ornamental self with physical and ideological attractiveness.

Simultaneously, they also struggle with the real and ideal self in the process of online dating self-presentation. Further, according to the participants' data of this research, the introduction of the video personal display feature, which allows users to add a video of themselves on their profile on dating platforms, bringing a more multi-dimensional experience and rich dynamic perception transmission properties in personality shaping and self-presentation, is a welcoming feature that was positively evaluated by almost all participants in this research. However, it is worth noting there is less literature to support research in this area. Given the unique and intriguing findings of this research, there is much space and potential for further exploration of this aspect**.** Developments such as the "metaverse" (Dionisio et al. 2013) are likely to increase the use of technologies like virtual reality (VR), augmented reality (AR), and mixed reality (MR) in the evolution of future apps.

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The Chengdu Biennale and Wikipedia Art Information

Jonathan P. Bowen
London South Bank University
London, UK
http://www.jpbowen.com
jonathan.bowen@lsbu.ac.uk

Huan Fan
Sichuan University
Chengdu
China
crisly@foxmail.com

This paper explores aspects of the Chengdu Biennale (especially during 2021–22) and online art information associated with the arts in Chengdu, the historic capital city of Sichuan, a province of China. Specifically, some aspects of creating Wikimedia resources for cultural activities in China are covered, using Wikipedia, Wikimedia Commons, and Wikidata online facilities. A set of Chengdu arts-related Wikipedia pages have been created, together with the addition of associated photographs and metadata. Some of the problems of providing such resources are covered, including language and access issues. The information may be useful for others attempting similar projects.

Chengdu Biennale. Chinese art. Contemporary art. Digital culture. Wikimedia. Wikipedia.

1. INTRODUCTION

This paper records art-related activities and organisations including art museums in Chengdu, the capital city of the province Sichuan in China, and, more specifically, online information surrounding the Chengdu Biennale, held in the city during 2021–22. The first author (alphabetically!) is a computer scientist with an interest in digital culture (Bowen & Giannini 2014; 2021), specifically related to museums (Giannini & Bowen 2019a; 2019b; 2019c), and an expert in Wikipedia page creation and maintenance, especially with respect to cultural resources (Bowen & Angus 2006). He is a largely monolingual anglophone based in Oxford and London (Bowen 2020). The second author is based in Chengdu, with a deep interest in media arts (Fan 2019; 2020). She is a native Chinese speaker as well as being knowledgeable in English. The complementary skills of the two authors were essential in the production of this paper.

Section 2 provides some general information on artistic organisations and activities, including art museums, in Chengdu. Section 3 presents specific information on the Chengdu Biennale, founded in 2001, but reinvigorated in 2021. In Section 4, we present a case study covering the creation of Wikipedia information on the arts in Chengdu, and especially the Biennale. We provide some concluding thoughts in Section 5.

2. ART ORGANISATIONS IN CHENGDU

Chengdu Art Academy

The Chengdu Art Academy (成都画院) is an arts organization, supporting contemporary art and the Chengdu Art Museum with a collection of artworks, based in Chengdu. The academy is organised by the Chinese government. It recruits mature professional artists and most receive a salary for producing their work, but it does not operate as an art school.

The Chengdu Art Academy was founded in 1980, as the first Chinese professional art organization established by the Chinese government. Its remit includes painting and calligraphy creation, research into art theory, and academic communication. Originally the Chengdu Art Academy was housed in the Chengdu Culture Park. In 1983, it was moved to Zhijishi Street. The style of the buildings is a typical quadrangle of western Sichuan historic houses dating from the late Qing dynasty. In 2007, the premises were approved as a Sichuan Provincial Heritage Conservation Site. A project to protect and maintain the buildings was completed in 2008. The buildings are operated by the academy as the Chengdu Art Museum.

On 6 November 2021, at the Tianfu Art Park and at the start of the 2021 Chengdu Biennale, the Chengdu Art Academy launched two new

contemporary art museum buildings in the park, namely the Chengdu Museum of Contemporary Art and the Chengdu Tianfu Art Museum, forming a new focus for the Chengdu Art Museum. As a result, the academy is now based at the park.

Chengdu Academy of Fine Arts

The Chengdu Academy of Fine Arts (成都美术学院) is an art school, entirely separate from the Chengdu Art Academy, based in the Xindu District of Chengdu. The academy is associated with the Sichuan Conservatory of Music and has its facilities located at the Xindu Campus. It offers bachelor's degrees and master's degrees.

The Sichuan Fine Arts Institute (SCFAI) is in Chongqing but, since 1997, Chongqing has been a separate province from Sichuan and there was not an equivalent institute in Chengdu. One of the vice presidents of Sichuan Fine Arts Institute, Ma Yiping, organised some teachers from SCFAI to move to Chengdu and created the Chengdu Academy of Fine Arts in 2000, which is formally a school that belongs to the Sichuan Conservatory of Music.

Art Museums

The Chengdu Art Museum (成都市美术馆) is an art museum with a collection of artworks, based in Chengdu and run by the Chengdu Art Academy. It has been based in historic buildings at 59 Zhijishi Street. However, in 2021, the museum has been expanded with two new museum buildings in the Tianfu Art Park, with the launch of the 2021 Chengdu Bienniale.

The Chengdu Museum of Contemporary Art (成都市当代艺术馆) is a contemporary art museum in Chengdu, newly established as part of the Chengdu Art Museum. The museum opened within the Tianfu Art Park in the Jinniu District at the time of the 2021 Chengdu Biennale (see Figures 7–9), together with the Chengdu Tianfu Art Museum. It is operated by the Chengdu Art Academy. The museum complex consists of three buildings; the others house an art library and a humanities library.

This newly opened museum should not be confused with the existing and similarly named Museum of Contemporary Art Chengdu (MoCA, 成都当代美术馆), another contemporary art museum that opened in 2011 and is located at the Chengdu Tianfu Software Park.

The Chengdu Tianfu Art Museum (成都市天府美术馆) is a further art museum in Chengdu (see Figures 10–14). The museum is located within the Tianfu Art Park. It opened in the park, along with the Chengdu Museum of Contemporary Art, at the time of the 2021 Chengdu Biennale, held in these two museums, both run by the Chengdu Art Academy. The museum is intended to focus on local art in Chengdu. The roof shape of the building is in the form of hibiscus petals, the city flower of Chengdu (see Figure 10).

Tianfu Art Park

The Tianfu Art Park (天府艺术公园) is an urban park with two art museums, as mentioned above, in the Jinniu District, northwest of central Chengdu. The official launch of the Tianfu Art Park was held on 6 November 2021, with the opening of these two new museum buildings in the park, operated by the Chengdu Art Academy. These both border on Yinggui Lake (see Figures 6, 10, and 11) and now form part of the Chengdu Art Museum.

The Park covers an area of 3,033 acres, with scenic views. Yinggui Lake (迎桂湖), the main lake in the park, covers more than 200 acres. There are three lakes in total, Fangfei Lake, Hehua Lake, and Yinggui Lake. As well as the two museums, the park also includes the Tianfu Humanities and Art Library, co-located with the Chengdu Museum of Contemporary Art. In addition, there are art-related businesses in the surrounding area.

The Chengdu Biennale was held in the two new museum buildings in the Tianfu Art Park as well as other Chengdu locations in 2021 (see Section 3 below).

3. THE CHENGDU BIENNALE

The Chengdu Biennale (成都双年展) is a contemporary art biennale event in Chengdu, China, started in 2001 (Biennial Foundation 2021).

Overview

The entrepreneur Deng Hong funded the first four biennales (from 2001). From the fifth event (2011 onwards), the biennale has been co-hosted by local official cultural institutions in Chengdu. After the sixth biennale in 2013, there was an interval of the official event until 2021. During this period, another art event took place, known as the Anren Biennale, mainly privately funded and operated, starting in 2017.

The 2021 Chengdu Biennale started on 6 November 2021, running until 6 April 2022. The official launch of the Tianfu Art Park in the Jinniu District of Chengdu was held on 6 November 2021, with the opening of two new museum buildings in the park, operated by the Chengdu Art Academy. The Chengdu Art Museum surrounds a lake with two new museum buildings, the Chengdu Tianfu Art Museum and the Chengdu Museum of

Contemporary Art. Artworks by more than 270 Chinese and international artists from 35 countries are on display at the biennale. The theme of the 2021 biennale is “Super Fusion”. Chinese artists exhibiting at the 2021 biennale include He Duoling, Liu Jiakun, Xu Bing, Zeng Fanzhi, Zhang Xiaogang, and Zhou Chunya. International artists include Daniel Buren, Yoan Capote, Leandro Erlich, Carsten Höller, Anish Kapoor, and Jeremy Gardiner (see Figures 1 and 14; Gardiner 2021).

参展艺术家：阿列克谢·索科洛夫·康斯坦丁诺维奇（Alexei Sokolov Konstantinovich，俄罗斯）、阿列克谢·索科洛夫·列奥尼迪科维奇（Alexei Sokolov，俄罗斯）、阿列克谢·索科洛夫·列昂尼德（Alexei Sokolov Leonid，俄罗斯）、埃里克·帕西诺（Eric Pasino，意大利）、安娜丽莎·帕斯卡伊·塞乌（Annalisa Pascai Saiu，意大利）、坂井滋和（Shigekazu Sakai，日本）、比利·巴吉尔霍尔（Billy Bagilhole，英国）、陈曦、陈晓阳、邓强、顾跃、管怀宾、郭涛、后冈喜信（Yoshinobu Nochika，日本）、基亚拉·维塔利（Chiara Vitali，意大利）、焦兴涛、杰瑞米·加德纳（Jeremy Gardiner，英国）、金日龙、科西玛·布卡雷利（Cosima Bucarelli，瑞士）、劳拉·尤勒（Laura Yuile，英国）、李遂、李象群、利亚姆·沃克（Liam Walker，英国）、刘鹏（澳大利亚）、刘茜懿（日本）、柳青、洛伦佐·布里维奥（Lorenzo Brivio，意大利）、玛丽·格莱兹（Marie Glaize，法国）、玛丽亚·乔瓦娜·索德罗（Maria Giovanna Sodero，意大利）、梅健、米尔科·安德烈奥利（Mirko Andreoli，意大利）、尼古拉斯·弗洛赫（Nicloas Floc'h，法国）、牛大悟（Daigo Ushi，日本）、庞茂琨、裴丽、宋戈文、汪蓝、魏光庆、吕暹薰（Woonhae

Figure 1: *Chengdu Bienniale information on exhibited artists, including the UK artist Jeremy Gardiner (2021).*

Exhibitions

The following Chengdu Biennales (from 2001) and Anren Biennales (from 2017) have taken place:

1. In 2001, the 1st Biennale “Yangban Model Art in China” invited 120 artists to participate, mainly paintings on the easel.
2. In 2005, the 2nd Biennale “Spectacle: Century and Paradise” was internationalised, inviting six foreign artists to participate. It was held in the New International Convention Center, Chengdu Century City.
3. In 2007, the 3rd Chengdu Biennale “Reboot” was held. Its curatorial team included the domestic curators Feng Bin and Lu Hong, cooperating with Britta Erickson and Kuiyi Shen from the United States.
4. In 2009, the 4th Chengdu Biennale had “China Narratives” as the theme, with Jia Fangzhou and Zou Yuejin as curators, 120 participating artists, 271 works involving oil painting, ink painting, photography, video, sculpture, and installations. This exhibition was divided into five subthemes: “2008”, “History”, “Reality”, “Urban”, and “Rural”.
5. In 2011, the 5th Chengdu Biennale invited Lü Peng as the chief curator, named “Changing Vistas: Creative Duration”, including contemporary art, design, and architecture (Lü & He 2012). Two hundred artists from China and abroad participate in this exhibition. This time, the event learned lessons from the model of the Venice Biennale, with one main exhibition and other special exhibitions held at 16 local art museums, which successfully attracted approximately 280,000 visitors. The right to operate the Chengdu Biennale was taken over by the Government.
6. In 2013, the 6th Chengdu Biennale invited Feng Bin and Zhao Li as curators, consisting of two parts: “Relation” and “Young Artists of Ten Years”.
7. The event was not held as scheduled in 2015.
8. In 2017, the 1st Anren Biennale, “Today’s Yesterday”, hosted by a private organization in Chengdu, invited 189 artists from 18 countries and regions and more than 800 works.
9. In 2019, the 2nd Anren Biennale, “A Confrontation of Ideals”, was jointly curated by Lü Peng, He Guiyan, and the Dutch curator Siebe Tettero.
10. In 2021, the 3rd Anren Biennale invited Gu Yuan as the director, cooperating with the art critics/curators Wang Lin, Zhao Li, Xia Kejun, Gu Yuan, Elsa Wang, Li Xiaofeng, Wen Ya, etc. They separated the areas to become the curator of each subtheme, inviting 150 contemporary artists and exhibiting more than 300 works. In the same year, the 2021 Chengdu Biennale was held in Chengdu Tianfu Art Museum and Chengdu Museum of Contemporary Art, and 272 artists were invited to participate, and 17 special invited exhibitions were exhibited in several local art galleries in Chengdu at the same time (Chengdu Biennale Organization Committee 2021). For example, the special invited exhibition “Still on” was held in the Usunhome Art Museum.

4. WIKIPEDIA CASE STUDY

Wikipedia pages

At the start of writing this paper, there was little information about the Chengdu Biennale to be found on Wikipedia (https://www.wikipedia.org). The Chinese-language Wikipedia included a rather out of date page with information largely dating from 2011, when it was created (Wikipedia 2022d). There was no matching English-language page. The first author created an initial page in English based on English-language information available on the web (Wikipedia 2022c). With the re-enlivened 2021 Chengdu Biennale held at the newly created Tianfu Art Park (see Figure 6 later) and its two newly built museum buildings (see Figures 7 and 10), there are a significant number of web-based articles on the opening of the biennale and the new museums, some of which are referenced on the Wikipedia page (Wikipedia 2022c).

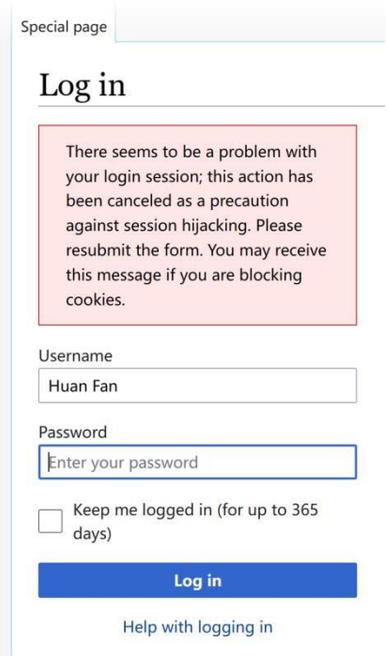

Figure 2: *An issue logging into Wikimedia.*

The second author then provided more detailed information in English and Chinese, especially in the history of the Chengdu Biennale, with a significant number of Chinese-language online references. However, accessing Wikipedia from China can be problematic. Issues with cookies can cause log in problems (e.g., see Figure 2). In any case, a VPN (Virtual Private Network) is required to allow Wikipedia to be read. In attempting to update Wikipedia pages from China, it was discovered that the VPN IP address was blocked by Wikipedia for editing, probably due to previous bad editing by others on the same IP address (see Figure 3). Thus, a combination of the Great Firewall of China due to Chinese censorship (Harrison 2019; Yang & Roberts 2021) and IP address blocking makes both reading and writing of pages problematic. Reading pages can be overcome using VPN access but writing or updating pages proved more difficult.

Figure 3: *Blocked from creating an account on Wikipedia due to the IP address used.*

With the access difficulties from China, the first author used material provided by the second author to improve the information significantly on both the Chinese and English pages, with appropriate Chinese-language references added to the latter. The information on Chengdu art in Section 2 and on the Chengdu Biennale in Section 3 is largely based on the relevant English-language Wikipedia pages, but since the two authors wrote the material for Wikipedia, they do not feel too bad about this blatant plagiarism! In summary, read access to Wikipedia is possible in China with a VPN (e.g., see Figure 4), but write access is more difficult.

Figure 4: *A screenshot of the Chinese-language version of the Chengdu Biennale Wikipedia page, as viewed in China.*

In addition to Chengdu Biennale Wikipedia pages in English and Chinese, the first author has written associated and interlinked English-language Wikipedia pages on the following, with information including Chinese-language references and answers to queries provided by the second author:

- Chengdu Academy of Fine Arts
- Chengdu Art Academy
- Chengdu Art Museum
- Chengdu Culture Park
- Chengdu Museum of Contemporary Art
- Chengdu Tianfu Art Museum

- Tianfu Art Park
- Yinggui Lake

A new Wikipedia "category" was created, called "Arts in Chengdu", and all the above pages, together with further relevant and existing pages (and categories) were added under this category (Wikipedia 2022b).

It is interesting to note that some of the institutions covered do not (yet) have dedicated websites, even in Chinese. In China, there is more reliance on homegrown technologies such as Weibo, e.g., for the Chengdu Art Academy (Weibo 2021).

The information in English and Chinese within the various Wikipedia pages was checked by the second author for correctness and completeness (e.g., see Figure 5) and then updated as needed by the first author. Note that on Wikipedia, it is important to cite reliable references for information that is included. These can be in any language. Obviously, in this case, both Chinese and English language references were useful. However, Wikipedia considers some sources of information to be "unreliable" (for example, Baidu), so one must be careful to find reliable secondary and independent sources to confirm information included on Wikipedia, ideally as cited footnotes. Otherwise, pages can (in due course) be updated by other editors with requested for citations, removal of unreliable references, deletion of unconfirmed information, etc.

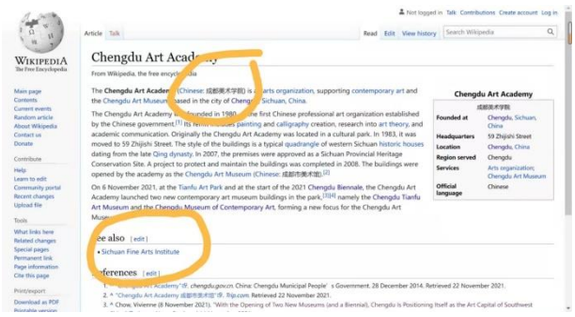

Figure 5: *An issue with the Chinese name on an English-language Wikipedia page.*

Each page can ideally include an appropriate Wikipedia "infobox" with entries about the subject of the page in a standardised format, depending on the precise infobox that this used. In addition, all the pages created have been linked from other related pages on Wikipedia. This is always worthwhile to avoid a page being marked as an "orphan". As noted above, pages should also be well-referenced throughout with citations and footnotes to avoid future issues being raised by other Wikipedia editors. Some additional references have already been added at the request of other Wikipedia editors where that have deemed that a citation is needed. We have mainly added Chinese-language references in these cases, so both authors were involved with this. The second author found the references and the first author added them to Wikipedia in the appropriate format, with the Chinese title and an English translation of this included.

Wikimedia Commons

Wikipedia pages are best illustrated with photographs where appropriate. This can be done directly by uploading to Wikipedia itself for a specific purpose on a particular page if no copyright-free image is available (e.g., for someone who is no longer alive and where not easily accessible image free of restrictive copyright is available). This can be done under "fair use" rules in American law. However, if possible, it is much better to upload image files to Wikimedia Commons (under https://commons.wikimedia.org) with an appropriate Creative Commons licence that allows general use on Wikipedia and elsewhere. It is easiest to upload one's own photographs since one can then assign the Creative Commons licence oneself, without seeking permission from anyone else.

The second author had several photographs available that were suitable for this project. However, again for similar reasons to those for Wikipedia mentioned earlier, it proved impossible to upload photographs directly from China. Wikipedia Commons does allow photographs on the Flickr website (https://www.flickr.com), with an appropriately unrestrictive Creative Commons or Public Domain notice, to be transferred without too much difficulty. Fortunately, it is possible to upload photographs to Flickr from China. Initially, these were assigned the default "All Rights Reserved" copyright notice. However, the second author changed this to "Public Domain", allowing the transfer to Wikipedia Commons to be allowed.

Once this was done, it was possible for the first author to place the images on Wikimedia Commons (see Figures 6 to 14, all originally taken by Huan Fan). Appropriate categories and descriptions were added to each of the images to make them easier to find by other users. In this case, Wikimedia Commons categories were added for each of the newly created Wikipedia pages (with the same name) if there were any relevant photographs to be included. In addition, all the photographs have been included under the Wikimedia Commons category "Chengdu Biennale" (Wikimedia 2022). Subsequently, it is possible to add these photographs to Wikipedia pages as required and this has been done with a selection of the photographs in the various Wikipedia pages mentioned earlier.

Figure 6: *Yinggui Lake in Tianfu Park, with the Museum of Contemporary Art in the distance.*

Figure 7: *A corner of the Museum of Contemporary Art.*

Figure 8: *Inside the Museum of Contemporary Art.*

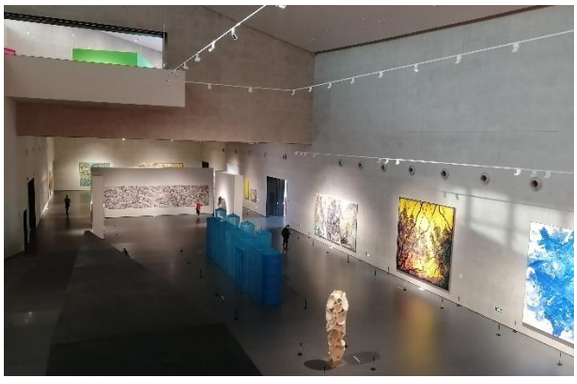

Figure 9: *The ground floor of the Museum of Contemporary Art.*

Figure 10: *The Tianfu Art Museum from across Yinggui Lake.*

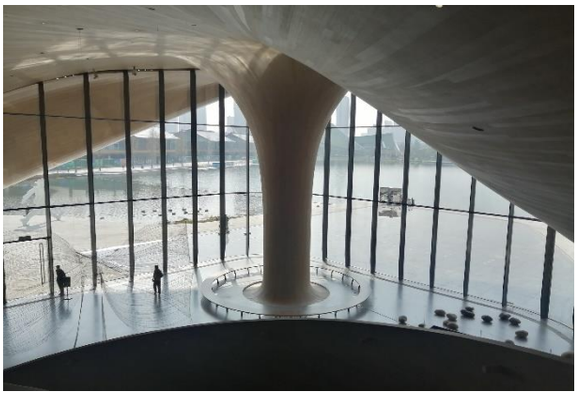

Figure 11: *Exit hall of the Tianfu Art Museum.*

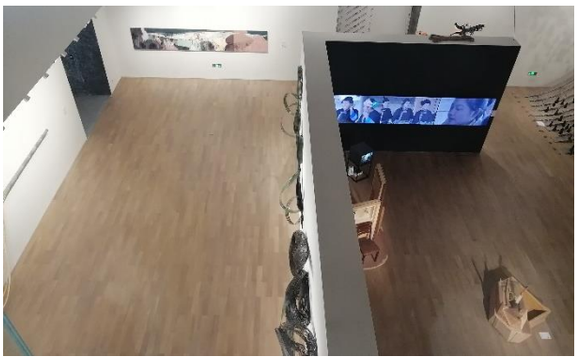

Figure 12: *Gallery 1 of the Tianfu Art Museum.*

Figure 13: *Gallery 13 of the Tianfu Art Gallery.*

Figure 14: *Gallery 13 in the Tianfu Art Museum, with artworks by Jeremy Gardiner (2021).*

Wikidata information

The Wikidata project (https://www.wikidata.org) is a less visible but important aspect of the various Wikimedia projects, of which Wikipedia is most well-known, and Wikimedia Commons is highly visible with its image repository. Wikidata records metadata on items that may or may not be in Wikipedia. Created pages on Wikipedia will eventually appear as an automatically generated Wikidata data item. It is also possible to create such data items manually, independently of whether there is an associated Wikipedia page.

In any case, it is well worth proactively creating a Wikidata data item for any newly created Wikipedia page. First, one should search the Wikidata site with the name of the Wikipedia page to ensure that an appropriate data item does not already exist. If it does, this can be edited. If it does not, and this is the most likely scenario, an initial data item can be created with the name of the page (ideally the same as the name of the associated Wikipedia page), a brief description, and, if appropriate, alternative names. Wikidata will automatically assign a unique numerical identifier, e.g., "Q11074639" for the entry on the "Chengdu Biennale (Wikidata 2022).

Once created, it is possible to add the names and brief descriptions in different languages as well as English. For this project, adding the Chinese name is obviously appropriate as a minimum. The item should be marked as an "instance" of at least one suitable data item type that is already in existence on Wikidata. For example, the data item for the Chengdu Biennale has been marked as an instance of "biennale". An image can be added if at least one that is relevant has been created or already exists on Wikimedia Commons.

Further information such as the date of "inception", the "country" (e.g., "People's Republic of China"), "location" (e.g., "Chengdu"), "coordinate location" (which can be determined using Google Maps for example), "organizer" (e.g., "Chengdu Art Academy"), etc. (Wikidata 2022). Links to the English-language Wikipedia page, equivalent pages in other languages, and the matching Wikimedia Commons category providing images associated with the item if it has been created, can and should also be added. This allows the various language versions of Wikipedia and the associated category on Wikimedia Commons, to know that they are all interrelated.

Doing all this soon after creating Wikipedia pages and Wikimedia Commons means that the interrelationships are established quickly within the Wikimedia project overall. Once done, the markup "`{{Wikidata Infobox}}`" can be included at the start of the associated Wikimedia Commons category, which then includes the Wikidata as an infobox in the displayed Wikimedia Commons page, obviating the need to add any other information. Overall, ensuring the relevant matching Wikidata page is reasonably complete is highly recommended for Wikipedia pages.

5. CONCLUSION

This paper records art-related information relevant to the historic city of Chengdu in China. Specifically, activities related to the Chengdu Biennale, especially the most recent one during 2021–22, are covered. The authors jointly created Wikipedia, Wikimedia Commons, and Wikidata information related to the Biennale in both English and Chinese. The paper has presented some of the issues in doing this, which may be a helpful starting point and others wishing to provide similar online information for locations where there is restricted Internet usage, utilizing related Wikimedia projects. It is hoped that this paper will provide some guidance on how to do this.

Note that there is an online Chinese-language encyclopaedia, *Baidu Baike*, that is monitored and censored by the Chinese government (Wikipedia 2022d). For example, compare information on the leading Chinese artist and activist Ai Weiwei (2021) on Wikipedia and Baidu Baike. The latter does not even include a page on the artist. Baidu Baike claims copyright on all its material, whatever the source. This contrasts with Wikipedia, which provides its material under a Creative Commons licence (Creative Commons 2022). Baidu Baike is far less referenced compared to Wikipedia in academic citations, demonstrating a lack of trust in it (Li et al. 2021). There is some information related to the Chengdu Biennale, but no specific page on it. A comparison of Wikipedia and Baidu Baike in the context of the arts would be an interesting future research topic.

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More than Human: Merging real and virtual states of being from arts and culture to wellness in a post-Covid world

Tula Giannini
Pratt Institute
School of Information
New York, USA
http://sites.google.com/view/tgiannini
giannini@pratt.edu

Jonathan P. Bowen
London South Bank University
School of Engineering
London, UK
http://www.jpbowen.com
jonathan.bowen@lsbu.ac.uk

Since the onset of Covid in tandem with major advances in computational culture, AI and machine learning, and sociocultural movements around diversity, equity and inclusion, the move to digital life has been rapidly accelerating causing a transformational change in the art world. From museums and galleries to the rise of digital art and artists, the changes wrought by the pandemic tied to political turmoil are causing a reshuffling of what was the cultural milieu, to a new cultural landscape that is at once global, multicultural, and human-centred.

Covid-19 pandemic. Digital art. Digital culture. States of being. Virtual Reality

1. BACKGROUND

Now heading into the third year of Covid, in 2022, with no end in sight, major shifts to human patterns of life elicited by a radical change in human communication, interaction, education, and the arts have required humans to adapt to the digital world in ways and at a speed unanticipated pre-pandemic (Bowen & Giannini 2021; Giannini & Bowen 2021; 2022). The fast-forward pace of Artificial Intelligence (AI), neural networks, and related platforms, increasingly impacts human freedom and identity (Bowen et al. 2021), while our identity continues to evolve as if synchronised to the life of the virus, we call Covid.

Having little choice, we retreat into digital life (Giannini & Bowen 2016), characterised by isolation, loneliness, and depression, the new normal that we are unconsciously adopting while we seem no longer sure of what it means to be human – our states of being (Bowen et al. 2018) eroding, caught in the crosshairs of our battle to exist, against all odds. Thinking from past to present, reflecting on human states of being in such a highly dynamic yet gloomy environment, this paper focuses on the emergence of new trends in museums and digital art/culture (Giannini & Bowen 2019a; 2019b) that evoke human emotions inspired by connections with nature, identity and psychological states of mind and wellness that find their precursors in late 19th-century and early 20th-century art and music. Arriving now at this auspicious moment in digital time and space, we observe how Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are creating new opportunities for emotional and immersive experiences between real and virtual states that attest to the human spirit of creativity and invention as if seeing digital light in a tunnel of darkness, leading to new ways of being more than human, while connecting with both artificial and natural states of being and ways of healing the body and soul.

2. MERGING THE REAL AND THE VIRTUAL

Digital identity, light and colour has captured the art world, seen in the rising presence and public engagement with Vincent van Gogh (1853–1890) and Claude Monet (1840–1926) immersive experience exhibitions leading the way to a new art destination, where audiences connect to impressionist and post-impressionist art aesthetics invoking a magical sense of nature and colour wrapped in deep human emotion of the inner self-revealing the conscious and unconscious mind, a trend mirroring the French impressionist poets in the likes of Arthur Rimbaud (1854–1891) and Stéphane Mallarmé (1842–1898), who in turn directly

influenced the father of impressionism in music, Claude Debussy (1862–1918), his musical language of chromaticism, and his going beyond western music to the sounds of the Javanese gamelan which he heard at the Universal Exhibition in Paris,1889, foretold the embrace of non-western musical language as it set the stage for 20th-century new music.

Thus, we bridge from the late 19th century and the pandemic of 1918, the year Debussy dies on 25 March, and World War One ends on 11 November, to the present, in a world dominated by the pandemic amid radical sociocultural transformational change, especially seen in the rise of digital art, the popularity of new digital exhibition venues and the broad acceptance of artificial life as our journey into unchartered territory continues, where human and artificial life evolves alongside Covid.

Life in the Abstract **(by T. Giannini)**

Life in the abstract
No contact
No fact
Just fiction
Covid
pushes us apart
Sadness of the heart

Nothing seems real
Can't feel
your gaze
out of sight
in the haze
of digital light

No hand to hold
as life unfolds
Stories untold
of suffering and sadness
Just Covid madness

Imagining the future
Close your eyes
Visualise
the beauty of nature
Monet's landscapes
Debussy's soundscapes

Escape from Covid
Escape from grief
What's left
but the belief
in art and emotion
A powerful potion
for wellness and love

More than human
states of being
Seeing
Munch – The Scream
Rousseau – The Dream
Emotion in art
States of the mind
And the heart

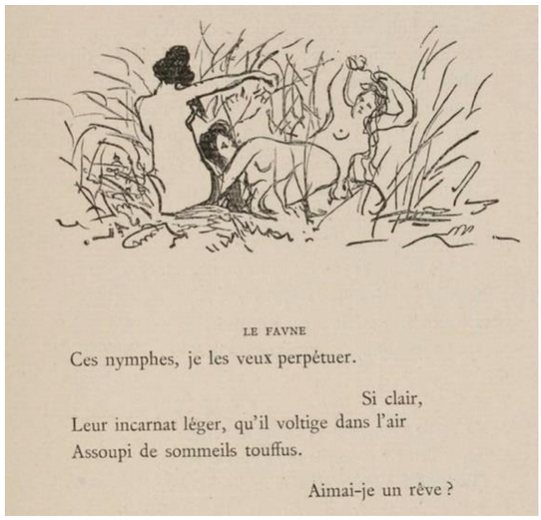

Figure 1: *L'après-midi d'un faune by Stéphane Mallarmé, 1876, 1st edition, illustration, Édouard Manet.* https://gallica.bnf.fr/ark:/12148/btv1b8625643g/f11.item

Figure 2: *La Seine à Port-Villez by Claude Monet, 1894, the same year of Debussy's Faune. Monet captures the colour palette of Debussy's Faune, featuring the sound of the flute in blues and pinks.* https://commons.wikimedia.org/wiki/File:Monet-seine-rouen.jpg

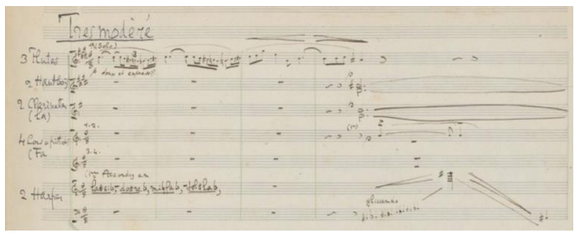

Figure 3: *Prélude à l'après-midi d'un faune, by Claude Debussy, 1894, autograph music manuscript, flute solo, measures 1–4, composed after the poem of that title by Stéphane Mallarmé, 1876. Bibliothèque Nationale de France, Département Musique, MS-17685.* https://gallica.bnf.fr/ark:/12148/btv1b55001035h/f9.item.r=debussy%20l'apres%20midi%20d'un%20faune

Figure 4: *Portrait of Stephan Mallarmé by Édouard Manet, 1876, the same year as L'après-midi d'un faune.* https://artsandculture.google.com/asset/st%C3%A9phane-mallarm%C3%A9/dQE80gCkrM68mA

The portrait of Stéphane Mallarmé (1842–1898), the French symbolist poet and critic, associates a group of painters, poets, and composers who embody the pinnacle of French 19th and early 20th-century art (see Figures 1–4). All artists whose close relationships and shared passion making art produced works that continue to the present to delight, astonish and inspire the human spirit around the globe, and especially now, as we find ourselves in the midst of a pandemic experiencing deep emotions across a wide spectrum of feelings, from grief, loneliness, separation to unexpected moments of joy and creativity.

The publication of Mallarmé's book-length poem *L'après-midi d'un faune* in 1876 enjoys sensational success owing to its sensuality, subject matter and beauty of word-sound. 18 years later in 1894, Claude Debussy (see Figures 5 and 6) writes one of the most influential compositions of the 20th century – *Prélude à l'après-midi d'un faune.* And, in the same year, Claude Monet invites Paul Cézanne (1839–1906) and his other artist friends, Mary Cassatt (1844–1926), Pierre-Auguste Renoir (1841–1919), and Auguste Rodin (1840–1917), to his home in Giverny.

From Gustave Courbet's (1819–1877) portrait of the great French poet Charles Baudelaire (1821–1867) in 1849, Édouard Manet's (1832–1883) painting of Stéphane Mallarmé in 1876, to Debussy's 1894 *Faune*, the same year that Claude Monet invites his circle of artists to Giverny, these artists and poets devote themselves to speaking for artistic freedom and individual identity. Their shared passion is foundational to the strong relationships shared between impressionist and symbolist artists, poets, and composers. Debussy's *La Mer* ("The Sea", three symphonic sketches), composed during 1903–5 and completed at the Grand Hotel on the English Channel, introduces non-western elements in music. Debussy chooses Hokusai's *The Great Wave* for the cover page of the score's first edition (see Figure 7), showing his predilection for Japonisme in art.

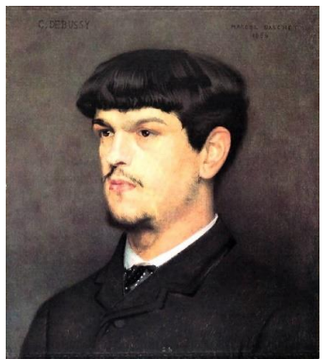

Figure 5: *Portrait of Claude Debussy by Marcel Baschet (1862 –1941), 1884. The French 20 franc note shows this image with "La Mer" in the background.* https://en.wikipedia.org/wiki/File:Debussy-by-Baschet-1884.jpg

Figure 6: *Javanese gamelan at Universal Exhibition in Paris, 1889. Debussy was there and heard this gamelan. National Museum of World Cultures of Leiden.* https://bibliolore.org/2012/08/22/debussy-and-gamelan/

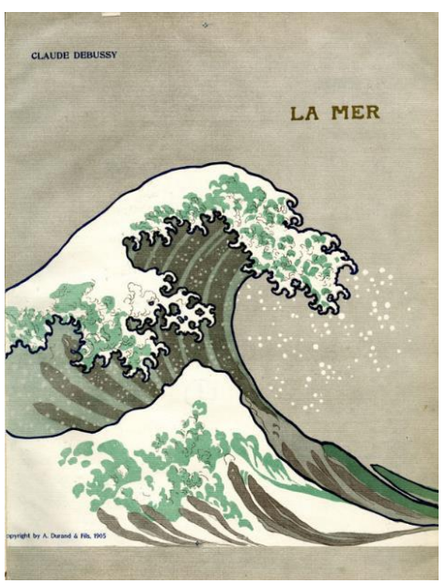

Figure 7: *Hokusai's The Great Wave, on the cover of Debussy's first editions of La Mer, published by Durand, 1905.* https://commons.wikimedia.org/wiki/File:Debussy_-_La_Mer_-_The_great_wave_of_Kanaga_from_Hokusai.jpg

With *La Mer*, Debussy's new musical language creates a revolution in music – from his 24-tone chromaticism and integration of non-Western elements, he invokes new ways of expressing the sea through the lens of human emotion, colour, and cultural cross-pollination.

3. MENTAL STATES OF BEING

The self-portrait of Edvard Munch (1863–1944) painted during the Spanish flu (see Figure 8) draws on elements of *The Scream* (see Figure 9), especially Munch's facial expression depicting despair and pending doom while the waviness and colours of the landscape take on the emotions of the human scream. In essence, when we experience intense emotional disturbance – everything looks different and somewhat distorted. This version, executed in 1910 in tempera on cardboard, is the same year Henri Rousseau (1844–1910) paints *The Dream* (see Figure 10) in the last year of his life. Seeming to be in sharp contrast to one another, *The Scream* and *The Dream* rather represent two extreme points of human states of being – from inner despair to ethereal delight.

Figure 8: *Self-portrait of Edvard Munch during the Spanish flu, 1919, National Museum of Art, Architecture and Design, Oslo, Norway.*
https://commons.wikimedia.org/wiki/File:Edvard_Munch_-_Self Portrait_with_the_Spanish_Flu_(1919).jpg

Rousseau paints what looks like a virtual dream world, a tropical jungle scene created from his imagination (see Figure 10). From the lens of contemporary states of being, living in a world where reality and virtuality intermingle (Bowen et al. 2021), we are challenged in our understanding of the self, as identity flows between imagination, interpretation and emotion. For Van Gogh, nature and art seem to be the arbiter of this polarity. As human digital behaviour evolves more rapidly than ever, under the weight of the pandemic and advances in computing and technology, more time is spent in virtual worlds and digital activity. Have we lost control over our environment and existence?

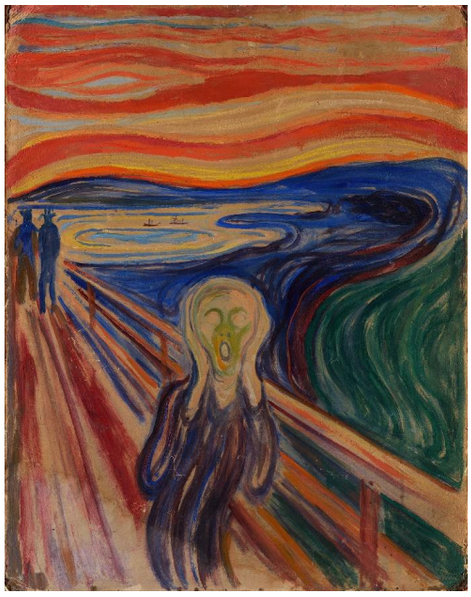

Figure 9: *The Scream by Edvard Munch, 1910.*
https://commons.wikimedia.org/wiki/File:Edvard_Munch_-_The_Scream,_1910_(Munch_Museum).jpg

Figure 10: *The Dream by Henri Rousseau, 1910. An imaginary place, both idyllic and scary, with wild animals hiding in the jungle.*
https://commons.wikimedia.org/wiki/File:Edvard_Munch_-_The_Scream_-_Google_Art_Project.jpg

During the year that Van Gogh is hospitalised at Saint-Rémy, he produces some 150 paintings. His states of being swing from elation about his highly productive year to depression, being in a fragile mental state and under medical care at the asylum, at the Hospital Saint-Paul in Saint-Rémy-de-Provence (see Figure 11). In Spring 1890, he falls into deep despair leading him to attempt suicide by shooting himself; death follows.

Figure 11: *Trees in the garden of the Hospital Saint-Paul, at Saint-Rémy, by Vincent Van Gogh, October 1889.* https://commons.wikimedia.org/wiki/File:Hospital_at_Saint_Remy.jpg

Van Gogh spends a year from May 1889 to May 1890 undergoing psychiatric treatment at the asylum of the Hospital Saint-Paul (see Figure 11). His highly unstable emotional state and mood swings trigger a mental breakdown – but despite this, during his time at the asylum, he remains highly productive.

Departing from Saint-Rémy-de-Provence because he wishes to be closer to his family, he moves to the northwest Paris suburb of Auvers-sur-Oise, a community of artists, where he dies on 20 July 1890, aged 37. His iconic painting, *The Starry Night*, now seen around the world in Van Gogh Immersive Experience Exhibitions, is painted in June 1889, so a few weeks after he is hospitalised, and provides a stark example of how much we still need to understand about human states of being.

During Vincent's final months of his life in Auvers sur-Oise, he makes new friends and throws himself into painting. Yet after a visit to his brother, Theo, Vincent grows very concerned about his financial future. This uncertainty becomes too much to bear on top of his illness. In an 1890 letter to Theo, shortly before his death, he tries to express in words his "sadness, extreme loneliness" but can only do so through his paintings of "wheatfields under turbulent skies."

> "… once back here I set to work again the brush however almost falling from my hands – and knowing clearly what I wanted I've painted another three large canvases since then. They're immense stretches of wheatfields under turbulent skies, and I made a point of trying to express sadness, extreme loneliness. You'll see this soon, I hope – for I hope to bring them to you in Paris as soon as possible, since I'd almost believe that these canvases will tell you what I can't say in words, what I consider healthy and fortifying about the countryside." (Van Gogh 1890)

The painting, poetry and music of these French artists resonate more than ever with today's American artists and audiences, and, as if by plan, the great symbolist poet, Arthur Rimbaud (1854–1891), dies in Marseilles, the year after Vincent's death, also at the age of 37. They seemed to live in parallel time, both producing revolutionary visions about life and art, and breaking free from long-held social norms to achieve their artistic purposes. Rimbaud writes in his most influential work of 1873*, Une saison en enfer,* "j'ai assis la Beauté sur mes genoux – Et je l'ai trouvée amère" (I placed beauty on my lap, and I found her bitter). These oft-quoted words of Rimbaud symbolise a move away from idealised "beauty" to nature, the mind, and senses.

From impressionism and symbolism to abstract art and digital art, we experience a paradigm shift from 18th-century realism to nature imagined through emotional states of being, and digital light as a key interpretive force. This is evident in immersive experiences based on Van Gogh and Monet, while Debussy brings colour, light and nature to music, as he replaces traditional tonality with a new chromaticism heard in *Faune*, in the sound of the flute playing the opening measures, marked soft, sweet, and expressive (piano, doux, et expressif) – Voilà! Modernism in music is revealed in a whisper (see Figure 3),

4. IMMERSIVE EXPERIENCE, VR AND NFTS

When *Van Gogh, the Immersive Experience* bursts into the contemporary consciousness of the art world and the public, the notion of the immersive experience takes centre-stage. This leads to a renewed awareness of the power of immersive experiences in the digital arts to lift our spirits, evoke emotions, and transform of our states of being, especially during the bleakness of the pandemic. It is as if Van Gogh is speaking to us, telling his story about human identity and states of consciousness (Bowen et al. 2019).

Denés Ruzsa (born 1982) is a Hungarian filmmaker and digital artist. Using digital light, colour, imagination, and emotion, he depicts the natural world from a planetary and biosphere perspective reflecting his dedication to Earth's climate and atmosphere (see Figure 12). Although the tools and mode of expression change with digital art, the themes of nature and human aesthetics (Bowen et al. 2017) persist in the 21st century. Digital art crosses all boundaries, from representational to abstract, and across all digital media. And now with VR, AR, and MR, digital artists are inspired by new digital tools that are empowering creativity.

In this age of computational culture, human digital behaviour and computing become integrated into human identity (Bowen et al. 2020) and entrenched as part of human existence, the human body and mind. This is most understood through digital art and artists – where art expresses human feeling, emotions, and senses – the digital and physical human states of being (Bowen et al. 2018) fuse into one, with embedded devices that act as extensions of human physical and mental powers mirrored in digital states, most recently in NFTs (Non-Fungible Tokens).

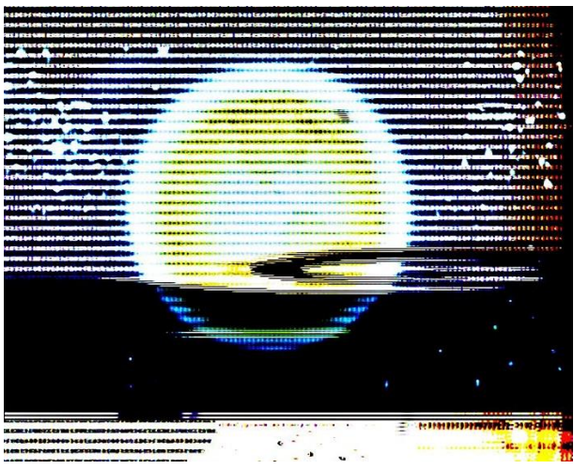

Figure 12: *Early Earth, digital art by Dénes Ruzsa, 2017.* https://commons.wikimedia.org/wiki/File:Digital_art_by_D%C3%A9nes_Ruzsa._Early_Earth._2017.jpg

The artist, David Cronenberg, a filmmaker who explores intersections between humans and technology, says, "Technology is an extension of our bodies," (Yerebakan 2021) creates his first NFT about his own death that captures the reality of death in a fantastical virtual moment entitled *The Death of David Cronenberg*. (SuperRare 2022). Not surprisingly, Mark Zuckerberg of Facebook, recently subsumed as "Meta", adopts this idea as a key facet of the metaverse (Frenkel et al. 2022), where humans will need to feel comfortable wearing digital devices such as smartwatches and VR headsets. There are certainly opportunities to present art in new animated and 3D ways (Davis 2021).

5. WELLNESS AND DIGITAL THERAPEUTICS

Figure 13 presents a larger-than-life exhibition of a vaccine needle, evoking the nightmare and anxiety of millions, as the Covid vaccine, like it or not, plays a part in the life of every human on planet earth. Figure 14 allows us to visualise the New York City subway system in the blue glow of "medical measures in public places," ultraviolet light that can kill the Covid virus. Figure 15 shows an NYC subway vending machine under blue light – don't leave without your PPE (Personal Protective Equipment)! And for those with a sense of humour, one might say that these subway settings could have been inspired by Van Gogh's *The Starry Night* blue glowing sky.

Figure 13: *Covid-19 vaccine awareness art installation, Radhanpur Cross Roads, Mehsana, India, August 2021.* https://commons.wikimedia.org/wiki/File:COVID-19_Vaccine_Awareness_Art_Installation_at_Radhanpur_Cross_Roads,_Mehsana,_India.jpg

Figure 14: *New York City subway – MTA launches UV pilot to kill Covid-19. Medical measures in public places.* https://commons.wikimedia.org/wiki/File:MTA_Launches_UV_Pilot_Proven_to_Kill_Covid-19_(49913415466).jpg

Figure 15: *Medical measures, deploying PPE vending machines across the New York City subway system.* https://commons.wikimedia.org/wiki/File:MTA_Deploys_PPE_Vending_Machines_Across_Subway_System_(50061253778).jpg

Doctors are using home-based virtual therapeutics and leveraging VR to improve mental health at scale with home-based treatments. Dr Brennan Spiegel, who works on the frontlines of Covid-19, is using VR for immersive therapeutics with excellent outcomes to treat anxiety, depression, and suicidal thoughts. Results of some 5,000 studies are especially revealing, showing that VR for home treatment, and for the visualisation of nature and its aesthetics, create what doctors are calling a "healing" environment (Spiegel 2020).

Covid – Stop stalking me **(by T. Giannini)**

Living with Covid
Can't see you
but know you're there
Stalking me
Everywhere
In despair
Wearing my mask
Avoiding life
Not knowing
when you'll strike

Mugged by Covid
Can I win this fight
Take flight
Hide
Don't go out
Shout – shout – shout

Seek stability
Feel tranquillity
The patterns of life
Repetition
Routine
But what lies ahead
unknown, unseen

6. ART, MEDICINE AND DIGITAL TECHNOLOGY

Immersive therapeutics conceptually tie to the goals of immersive Van Gogh and Monet exhibitions and touch upon deep psychological states of human identity (Bowen et al. 2018). Van Gogh's vision of nature meets those goals and goes beyond to express the emotional turmoil that millions of people are experiencing during Covid.

The last year of Van Gogh's life was at once highly productive and fraught with emotional swings. A study by two biological scientists, at the University of Portsmouth, shows that "recreational use of VR can successfully alleviate the negative impact of lockdown periods on the population's mental and physical wellbeing," a key finding with positive implications for using VR as a treatment for wellbeing during Covid isolation (Siani & Marley 2021).

7. CONCLUSION

Social VR platforms are becoming increasingly popular among users and, when compared to previous virtual worlds, they have unique immersive technical properties able to elicit intense feelings of presence. Overall, the findings reported here stress the strong association between such feelings of presence and the psychological rewards that users obtain in terms of relatedness, self-expansion, and enjoyment. This is, to the best of our knowledge, the first study providing a quantitative examination of those associations.

Hence, our research points out the important role that immersive VR technology may play in favouring social connectivity and users' wellbeing in scenarios where other options (e.g., face-to-face contact) are not available. This may refer to periods of social distancing but may also be applicable to other circumstances (e.g., long-distance couples or ex-pat workers). At the same time, our results reveal broad possibilities for social VR platforms to address self-expansion, helping users satisfy those self-related psychological needs that may remain unmet during everyday life. Thus, this study hints at the potential of social virtual reality applications for meeting users' psychological needs and opens avenues for future research addressing a more in-depth analysis of emerging social VR applications.

Acknowledgements
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Liveness for Contemporary Audiences: Developing online-togetherness in metaverse theatre audiences

James Simpson
Rose Bruford College
University of East London
48 Silver Lane, West Wickham, UK
james@coppercandle.co.uk

Rory Foster
Rose Bruford College
University of East London, 50
Woodleigh Gardens, Streatham, UK
rory@coppercandle.co.uk

Liveness for Contemporary Audiences: Developing Online-Togetherness in Metaverse Theatre Audiences is a research project owned and carried out by Copper Candle. The project is funded by Innovate UK as part of the Audiences of the Future Round 2 – Design Foundations Fund. Our activities have focused on the experience of making digital/virtual theatre as creative producers of the work. Within this research we are asking, both of ourselves and of the practice, "what do contemporary audiences want?" Or more specifically "what do contemporary audiences want from live digital/virtual theatre?" And where can we look for insight? For us, this is the games industry. Our working assumption is that audiences do want to experience live virtual events, based upon a clear uptake on this offering within the arena of gaming.

Liveness. Virtual theatre. Metaverse. Audience reception. Copper candle. Motion capture. Live streaming. Theatrical event.

1. INTRODUCTION

Liveness for Contemporary Audiences: Developing Online-Togetherness in Metaverse Theatre Audiences is a research project owned and carried out by Copper Candle. The project is funded by Innovate UK as part of the Audiences of the Future Round 2 – Design Foundations Fund. Our activities have focused on the experience of making digital/virtual theatre as creative producers of the work. Within this research we are asking, both of ourselves and of the practice, "what do contemporary audiences want?" Or more specifically "what do contemporary audiences want from live digital/virtual theatre?" And where can we look for insight? For us, this is the games industry.

Our working assumption is that audiences do want to experience live virtual events, based upon a clear uptake on this offering within the arena of gaming. This can be seen clearly when one takes into account virtual events such as Fortnite's 2020 Travis Scott performance, viewed by an audience of 12.3 million (Forbes 2020). But how does this want translate from live virtual concert, to live virtual theatre (both in terms of its reception and its validity as a theatrical form?

In this paper we will offer a definition of metaverse theatre and explore key issues within this new form of theatre-making, namely the creation of liveness and its relationship to the notion of online-togetherness. We also identity a bias that surrounds current discussions, which we believe emphasises the experience of the performer and maker, over that of the audience. It is our belief that a sense of liveness can be created within virtual theatre by exploring how the audience experience and interact with the event, which moves away from this performer-centric bias. This interactivity can be achieved by deploying multiple aspects of interactive game play used widely across the digital and online gaming arena.

The authors/researchers of this paper are both current PhD candidates at Rose Bruford College and University of East London. Their research projects are focused on two different sides of the same issue – charting and analysing keys issues within emerging intermedial and interdisciplinary

theatre practice, from the standpoint of the designer/technologist (James Simpson) and the point of view of the director/performer (Rory Foster). We also own and run a company called Copper Candle which is a technical innovation studio, producing projects for virtual live theatre and conducting R&D. The company's vision is to enable the production of theatre and live events in the new modes of digital and virtual production, with specific emphasis on the development of technologies and strategies for the creation of metaverse-theatre.

2. METAVERSE THEATRE AS A CREATIVE PRACTICE

The need for Live Performance in Mobile Based AR (Simpson 2021) was presented at EVA 2021, following an Innovate UK funded project called The Round. During this project we began to question the foundational use of our products. We were providing streaming solutions for live performances, hosted within game engines via various innovative new-to-market technologies. Our concern was that we were producing an overly elaborate technical solution – at great expense – to an audience that may not want, need, or even acknowledge that what they were watching was in fact live. This questioning led us to shift our research emphasis away from product research and development, towards more theoretical questions around what 'live' and 'liveness' means for this new mode of practice (live-virtual theatre making).

This research centres its discussion around our latest research enquiry, in which we seek to test and evaluate liveness from the perspective of the audience. We have coined the term Metaverse Theatre as a description of the technical and creative activity at the centre of this research.

The term virtual theatre is also used regularly in this area, as is digital theatre but they are all slightly different from each other. To be clear, here is our interpretation of the nomenclature and where our research sits within it.

Digital Theatre is most useful here as a blanket term which refers to all theatrical practice which harnesses and deploys digital technology as a means of staging and/or presenting the event.

Online Theatre: Theatre and performance which is recorded and viewed via a webpage or streaming service (such as Netflix or Digital Theatre+). It was originally intended and designed for a live audience but has been creatively modified to allow in-venue cameras to record it for post-production and editing, before being published.

Live-Streamed (Theatre): Theatre and live performance which are being filmed and streamed directly to a platform such as YouTube or Zoom. The production may or may not be attended by a live audience who are aware of the filming and the production would have been modified creatively to suit the needs of the camera and live stream.

Virtual Theatre: Theatre which actively applies virtual reality tools and techniques to stage part or the whole of an event, within a computer-generated virtual reality.

Metaverse Theatre: To give a totalising definition of the metaverse at this early stage of its development is foolhardy. However, we can propose that the metaverse is a network of virtual realities in which individuals can roam and interact with both the reality and others within it. Thus, metaverse theatre is a theatrical practice which not only deploys digital and virtual technology to create events, but also that these events are produced and performed for audiences within the metaverse

3. LIVENESS IN THEATRE

Digital theatre operates differently to traditional theatre, with audiences and performers separated through different space/ time – but there is more to be understood about what liveness is within both live theatre and digital theatre.

This is well-trodden theory, with the liveness debate firmly placed within performance theory and, particularly under discussions of the ontological nature of a given performance event. However, our starting point for discussing liveness, in this research, is no longer simple live-feed camera systems, as it was in its origins. But the creation of virtual realities where both audience and performer are immersed within a shared theatrical event – across multiple times and spaces. It is our assertion that the discussion around liveness needs to keep up with these technological advancements, by shifting what we understand about principles of liveness.

Philip Auslander, a preeminent performance scholar provides us with the framework on which to do this. Auslander started writing about liveness in the late 1990's publishing his seminal text; *Liveness: Performance in Mediatized Culture* in 1999. This was in reaction to previous speculation on liveness by his contemporaries, notably Peggy Phelan; whose take on liveness (to summarise briefly) was concerned with preserving the pristine natural of performance's ephemeral ontology, in the wake of huge intermedial activity in the theatre space (Phelan 1993).

Auslander introduced to the liveness debate a new sociological angle and has been one of the more fluid thinking (major) academics concerned with the debate, allowing his ideas and notions to evolve in relation to developments observed within theatre practice. Auslander posits that a sense of liveness within performance is not purely based upon a mutual time/space, in which the performers and audience coexist, but is exactly a conversation around forms of practice which question the existing theatrical paradigm.

In 2011 Auslander gave a keynote at the conference; *Transmediale*, in which he clarified and rectified his ideas on liveness. During this lecture he said 'the live is an effect of mediatisation, not the other way around. It was the development of recording technologies which made it possible to perceive existing representations as live' (Auslander 2011). Here Auslander is establishing an important proponent of this research. That it is only through the introduction of medial technologies into performance that we get to understand the paradigm of live / not live / liveness and, by extension, how this paradigm is relevant to both live and mediated theatre. Or as Auslander puts it,

> The history of live performance is thus bound up with the history of recording media, and extends over no more than the past 100 to 150 years. To declare retroactively that all performance before the mid-nineteenth century was "live" would be to interpret the phenomenon from the perspective of our present horizon rather than those of earlier periods. (Auslander 2012)

Here Auslander is emphasising the phenomenological importance of liveness, that liveness is not so much the resultant nature of a live event (an event taking place in one discreet time/space) but an experience of the event's own unique ontology. Liveness is an event specific phenomenon, which can only be understood in relation to the event to which it belongs. Thus, liveness in metaverse theatre can only be fully understood through the lens of the metaverse experience and it's down to the audience of metaverse theatre to evaluate and validate its own unique qualities of liveness.

If we take this to be the case then, at these early stages of investigation into this area of practice, we can posit that qualities of liveness in metaverse theatre are to be found in the nature of the metaverse itself, as exploited by theatrical convention. For us these qualities are interactivity, user agency and the use of branch narratives.

When we consider these in relation to theatre in the metaverse, we can easily assume that the term user can be exchanged with the term audience – but an audience which is inherently active in the mode of theatre they are engaged with.

4. THE PERFORMER-CENTRIC BIAS

During our previous research projects, we have begun to identify and recognise a trend we term the 'performer-centric-bias'. We believe that this, unconscious bias, is at play widely across the theatre industry and within the authors' own practices. Furthermore, we believe that this observed trend is having a negative effect on the discussion and development of new innovative theatre practice. Here we define the performer-centric- bias as a tendency for theatre makers, producers, performers, critics etc. to consider and focus on the experience of the performer in the development of theatrical events. Which unwittingly not only subjugates fellow workers within the theatre industry, notably the technical and design teams, but also the audience.

As we move into this new uncharted mode of theatre making, we propose a conscious abandonment of this performer-centric-bias in favour of establishing a non-hierarchical approach to understanding the roles of each attending individuals within a metaverse theatre event. Be those individual performers, technical designers, or the audience themselves. This non-hierarchical approach to development and research has stood the post-dramatic theory (Lehmann, 1999) in good stead to uncover key theoretical developments within the last 50 years of performance studies, by disavowing advancements of the theatrical from the outmoded confines and bias of its predecessors. Once again asserting the idea that new forms of practice are best understood through their own conditions and perspectives.

5. LIVENESS IN METAVERSE THEATRE

To examine our hypothesis of liveness in metaverse theatre this project will design, produce, and deliver our first offering of what metaverse theatre could be, the metaverse performance of *Hello World*. At the centre of our research and development of the performance is the exploration of what we believe to be the tenets of liveness in metaverse theatre – audience agency, interactivity and the use of branch narratives. This is the first piece of theatre, harnessing Copper Candle's own patented plugin technologies, to live stream motion capture performance into a shared metaverse performance space.

5.1 Audience agency

The audience are not only central to this research, but we believe central to the ongoing development

in this area of practice. As acknowledged metaverse theatre practice ruptures the existing paradigm of theatre, by dispersing its audience and its performers across different times and spaces. We believe that agency for the audience is essential, in order to keep a sense of connection to the performance, a sense of liveness. In *Hello World* we create this agency by endowing the audience with the ability to participate in the development and re-directioning of narratives. In other words, the audience are active participants in the unfolding of the story. Although this is not unique to metaverse theatre and this technique can be seen in other conventional theatre practices, such as immersive/participatory theatre, we are interested in testing how much agency an audience feels in metaverse theatre events. As we hope to understand more fully whether, in order for the event to have liveness, the audience need to have agency over the whole event, the narrative, or the performers. Or perhaps, only the illusion of agency is needed?

Hello World is engaged in by an audience through a bespoke user interface which provides them with a variety of interactive tools. Including the ability to choose their own POV from which they can observe the action. A chat function attached to the UI, in which the audience are invited to communicate with not only each other, but the performers in real-time. And also functions are available for the audience to provide feedback during the performance, by sending commands in the form of emotion reactions. Alongside this the UI also allows the audience to be a deciding factoring in how the event itself unfolds, through a voting mechanism.

5.2 Interactivity

As outlined above *Hello World* uses a UI with multiple interactive functions built in. Interactivity is the second tenet we explore throughout this research. It also allows us to have some control over the manner in which we create agency within the audience. The main points of interactivity for this research are, an ability to communicate with other audience members and the performers, emotion reaction commands, as well as the ability to vote on the outcome of narrative within *Hello World.*

Firstly, for an audience member to communicate with both the rest of the audience and performers is a function we built in to find out whether this is an ability virtual audiences want/need. The thought behind this functionality, is to help foster a sense of what we term ‘online-togetherness’. In other words, the awareness of yourself as a part of a greater online whole, cohered around a metaverse theatre event. This idea of online-togetherness is supplanted here from the wider activities happening within metaverse environments. Tech blogger Limarc Ambalina refers to this sense of togetherness in his article How *Fortnite Became the Modern-Day Community Center* for Hackernoon writing,

> Fortnite became a place to hang out with your friends, no matter what age you were. Personally, living in Tokyo, Japan, I find it hard to stay in touch with people in Canada. However, in 2019 and 2020, I often found myself catching up with friends over a 2-hour-long session of Fortnite. In many ways, Fortnite became the modern community center or outdoor basketball court where people came to socialize, regardless of their actual skill level in the game. It was an open place for everyone. (Ambalina 2021)

This research understands the act of theatre as fundamentally a social event, in turn echoing Auslander’s reading of liveness. And that this event is firstly to do with cohering an audience of people to create communities of experience. It is our intention that an engagement with the chat function of *Hello World’s* UI will help bolster a sense of online-togetherness and in turn begin to form a single community of audience, across multiple times and spaces.

Secondly, the UI’s emotion reaction commands. This is a simple command built into the experience of *Hello World.* It gives the audience members a chance to respond to the performance, with either a happy, sad, or applause reaction. These emotions choices are intentionally generic, in order to capture a large range of response, in a small range of choice. When an audience member selects one command, they are displayed a visual response on *their display only.* This response is also logged on a print screen for the performance, that only the researchers are able to view. We have introduced this function to test whether response to contributed reaction by audience members needs to be reinforced by the group to garner further engagement, or whether a computer-generated response would suffice.

Thirdly, the UI’s voting mechanism. At various points throughout *Hello World* the audience will be asked to vote on how they would like the narrative / performance to proceed. The voting function allows the audience to cast their votes through a single demand, rather than using the chat function (keeping it free for any ongoing discussion within the group). The voting mechanism serves three distinct purposes, firstly to help garner initial response in the audience, the narrative will not proceed without the audience’s vote. Secondly, it introduces potential for the research to understand the direct correlation between audiences simply engaging with the UI, or if they are also engaged with the narrative and theatre of the event. And thirdly, to provide a grounding mechanism for our third tenet – Branching narratives.

5.3 Branching narrative structures

Branch Narratives, or in the realms of gaming build-your-own-adventure is a concept in narratology that refers to a narrative in which its audience chooses (often at various points) how the story proceeds, think Assassin's Creed or Black Mirror's Bandersnatch. The narrative then, when turned into a schematic takes on the shape of a branch, with all the connective options set out against one another. As mentioned, this is a common concept for gamers, with a plethora of build-your-own-adventure games on the market, with a huge online audience. So, this research asks, why not build-your-own-theatre-show? Branching narratives are a proven method to ensure engagement with online gaming, which in turn create virtual communities, brought about through online-togetherness. Utilising the UI's voting function Hello World hopes to capitalise on this form of storytelling to help bolster engagement from its audience, as well as handing over agency to them.

5.4 Live and pre-recorded content

Throughout the series of 24 performances, presented over two days, these functions will be tested. This will be done by keeping these functions active, or not. In other words, at certain points in the performances the audience's votes will be monitored and taken into account and they will effect change in the performance. At other times this mechanism will be falsified, and pre-decided outcomes will run regardless of the audience interactivity. In addition, throughout the performance the audience will engage with a mixture of live-streamed and pre-recorded content, in an aim to question whether real-time content is important to the liveness of metaverse theatre or not. The UI chat function and emotion response buttons will stay active throughout the entire run of performances.

Our main aim throughout the demonstration is to lay the framework to ask a very similar question, articulated in a variety of ways. Is liveness in metaverse theatre to do with the audience being in a state of online-togetherness, or is it to do with the application of real-time content. Or perhaps there is a more dynamic answer, in which a combination of both in needed. The audience members will be invited to engage in comprehensive audience research, supported by the Audience Agency. This survey will assess these questions through gathering feedback on how the audience experienced our hypothesis of liveness within the performance.

Our notion here is that we are producing an experience which feels live because it has an "eventfulness" or "togetherness" which provides audiences with a sensation that they might call "live".

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Human Error: A collection of work that highlights our misuse of technology and the Internet

Jonah Brucker-Cohen
Associate Professor, Lehman College, City University of New York
Bronx, New York, USA
Jonah.bruckercohen@lehman.cuny.edu

1. INTRODUCTION

Today we are often confronted with computer interfaces that are built to be "easy to use" but are more confusing than ever. This paper details several artworks that fall under the theme of "Human Error" and consist of software and hardware devices that integrate elements of human error into their design to provoke and materialise human frailty when it comes to operating digital devices and interfaces.

Technology is often difficult to use, hard to understand, and confusing to configure. But is it really the technology that is confusing or is it what we bring to the technology? Is "Human Error" [3] [10] the cause of our troubles? "Human Error" is a series of projects that examines and catalogues things we as a population do wrong with technology and the Internet, ultimately making them more human than ever.

2. BACKGROUND

James Reason, former Professor of Psychology at the University of Manchester, coined the term "Human Error" (Reason 1990) in the late 1980s. Reason quantified human error in two distinct categories that of the person approach and the system approach (Reason 1990). While the person approach examines errors of individuals in areas of deficit such as forgetfulness, carelessness, negligence and similar, the system approach takes a wider stance and blames human error on organizational mishaps or structural systems that are difficult to master. The projects in this series focus on the "person approach" where most of the error correctable tasks could have been avoided entirely. "Human Error" Human Error Site (2022), features eight projects that begin the exploration of this theme and range from software to hardware installations. Below are some details on the projects included in the series.

3. PROJECTS

3.1 Letter dialler

Letter Dialler pictured in Figure 1, is an iOS app that removes the numbers from the phone dialler application. Instead of typing numbers, users are forced to remember the corresponding letter combinations associated with each number key to dial the correct number. The *Letter dialler* app highlights common errors that we as humans exhibit when using technology and why these errors have become almost second nature to its daily use.

***Figure 1**. User holding Letter.*

3.2 Password

Password, pictured in Figure 2, is a web form that asks users to type in a password and click the “Set My Password” button. Once clicked the new password is submitted to the server and automatically changed to the word “Password”. The continued use of the word “Password” as a password is still common and due to this word’s proclivity to be guessed by potential hackers.

Figure 2. *Screenshot of Password.*

3.3 Dim

Dim, is a Mac OS application that repeatedly dims the display of users to 50% every 5 minutes. Users must correct the dimness to 100% to get back to work, knowing that their screen will return to lower brightness shortly.

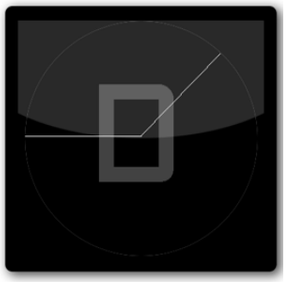

Figure 3. *Dim App Icon.*

3.4 PPRJM

PPRJM (Paper Jam is a printer that has been modified to continually cause a paper jam. This form of “Human Error” is something that continues to plague people who think they have correctly loaded paper but have failed due to their inability to follow directions.

Figure 4*. Screenshot of PPRJM.*

3.5 NoSGNL

NoSGNL is a modified monitor that continually changes the chosen signal to an empty source or “No Signal”. Despite the user’s best intentions to connect their device to the display.

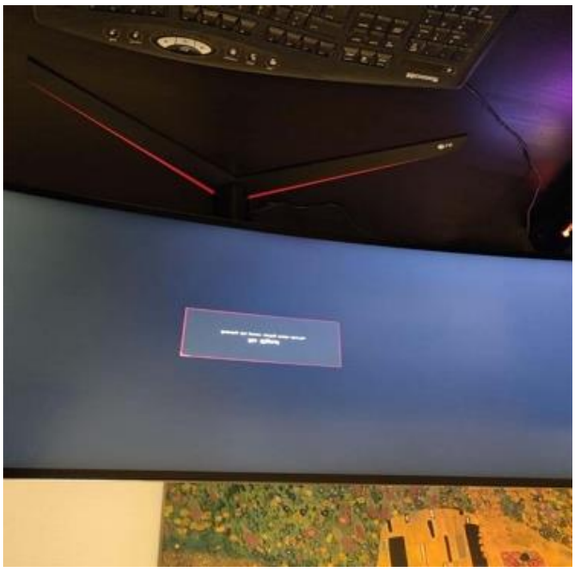

Figure 5*. NoSGNL.*

3.6 Theft ID

During the first half of 2021, 118.6 million people had their records exposed in data breaches and consumers lost more than $56 billion to identity theft and fraud. *Theft ID* (Figure 6) is a web-based form that includes all the necessary elements to cause Identity theft and relies on "human error" to fill in the form.

Figure 6*. Theft ID logo.*

3.7 CRWDDSTRIP

CRWDDSTRIP is a modified power strip that contains too many plug holes and spaces to allow for more than a single plug to fit. This form of "Human Error" is common with people who use multiple devices and never have enough plugs to plug them all in.

***Figure 7**. CRWDDSTRIP.*

3.8 Auto-CRCT

Auto-CRCT (Figure 8) is a text editor that automatically integrates “leetspeak” into typed messages, resulting in misconstrued messages and typos caused by these word shorteners.

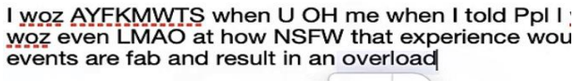

***Figure 8**. AutoCRCT.*

4. CONCLUSION

The works in the “Human Error” series are the beginning of a larger body of work that explore our ineptitude with technology and reminds us that we are not perfect in our abilities to understand, operate, and command use of the technology we depend on daily.

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Neuro Art: liminal reflection, introspection, and participatory art

Oliver Gingrich
Roehampton University
London, UK
olivergingrich@gmail.com

Shama Rahman
Hasso Plattner Institute
Berlin, Germany
rahman.shama@gmail.com

The emerging media art genre of Neuro-art builds on a rich history of more than 50 years: From artists such as Alvin Lucier's Music for a Solo performer (1965) to Refik Anadol's Lumen-Prize winning "Melting Memories", neuro-art interconnects scientific visualisation, biosensor feedback, while enabling new insights into the workings of the human brain. This paper provides insights into the history of neuro-art, as well as contemporary practices in the field: As practice-led researchers, the artists Oliver Gingrich and Shama Rahman provide an exegesis of key readings, while analysing their own practice against the backdrop of a historical context and the critical framework of phenomenology.

Neuro art. Brainwave art. Neuro feedback. New media art. Biosensors. BCI. HCI. Visualisation. Flow. Participatory art.

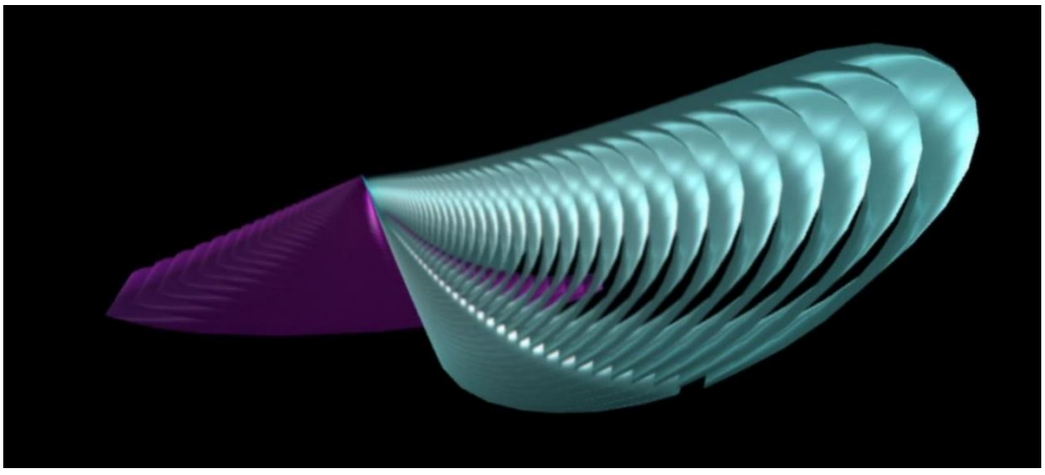

Figure 1: *Gingrich & Rahman: Zeitgeist, AI Neuro Art, 2021*

1. NOMENCLATURA OF A NEW GENRE

The nascent field of Neuro Art, also known as brain art, brainwave art or neuroarts has been the subject of significant number of recent publications (Nijholt 2019, Siler 2015, Gingrich 2018, Gingrich & Rahman 2021) and an array of artistic investigations that spans back several decades: As early as the 1960s, artistic practitioners examined the creative potential of the human brain to contribute to artistic outputs, directly or indirectly.

Artists such as Lisa Park, Mariko Mori, Lancel / Maat, Luciana Haill or recently Refik Anadol stand in this tradition, exploring both the diegetic as well as the mimetic or representational potential of the human brain. What new insights can representations of the human brain reveal? What new artistic experiences can the power of our brain contribute to? And can our cognitive potential help to provide new storytelling techniques? (Halttunen & Rahman 2021, Rahman et al. 2021).

From the outset the genre of neuro-art oscillated between extremes: mind-control (Eaton 1971) versus creative expression (Gingrich & Rahman 2021, D'aleman & Rahman 2021), technical gimmick versus sonic or visual art, artistic representation versus audience participation:

Some of the trends, trajectories and genres within this field have been identified by scholars such as Nijholt (2015) and Lysen (2019), pointing to a tight relationship between science, research and artistic practice, an ongoing dialogue that influenced and enriched both parties equally: Sci-art, new media art, and tech-art has long been criticised for operating outside of the rigorous spectrum of scientific research, with practices of free interpretation of data often circumventing critical questions on data accuracy, data measurements, confounding variables, with some critics even suggesting a form of pseudo-science. Yet, the realm of art has also enabled new forms of discourses, that focus more on the subjects of interface design, meaningful interactions between participants and the art they engender as well as the concept of neurofeedback.

2. GENESIS OF AN EMERGING ART FORM

The origins of EEGs or electro-encephalography date back to 1875, when the Liverpudlian Richard Caton published his findings on measures of brainwave activity on monkeys and rabbits in the British Medical Journal. From the 1930s and 1940s onwards EEG measures were used for clinical-analytical purposes as well as neurofeedback, a method of attempting to induce states of minds through a combination of measurement, and self-observation (Adrian & Matthews 1934; Kornmuller 1945 cited in Borck 2018).

The term neuroscience, however, is relatively new, and only dates back to the early 1960s (Duffin 2010). It was not until the mid-1960s and early 1970s that EEGs were used for artistic purposes, not at least to create experiential performances, with artistic, meditative and sometimes even hypnotic aspirations.

Alvin Lucier's pioneering artwork 'Music for a Solo Performer' is widely recognised as being one of the first recorded artworks to use EEGs and neurofeedback in a live performance context (Lysen 2019). Previous forays in creating art using EEG measurements include Dr William Grey Walter's 'cerebral music' (Haill 2019). Alvin Lucier's performance was inspired by the idea of entrainment, that by amplifying alpha waves, at 10khz inaudible to the human ear, the mind could be induced into a state of meditation.

While Alvin Lucier was interested in EEG as a facilitator for novel performance, the composer Manford Eaton was interested in alpha waves as a tool for mind control (Eaton 1971, Joseph 2011, Lysen 2019): Supported by the ministry of defence, Eaton's composition is now regarded as having had an ulterior motif: that of direct manipulations of his audience.

Whereas Manford Eaton, Alvin Lucier and contemporaries such as Richard Teitelbaum with his 1968 performance of 'In Tune' (Teitelbaum 1968) attempted this meditative state through an auditive and explicitly non-visual approach (Lucier 1995), other early neuro-artists explored the concept of neurofeedback through visual representation: William Grey Walter's toposcope for instance translated brainwaves into visual form: (Walter & Shipton 1951, p.282) While these early attempts of a visual interface for brainwaves was still both erratic and not easily intelligible (compare: Lysen 2019), they point to the emerging rise in artistic visual interpretations of neuro-activity.

3. NEUROCULTURE – A (BRAIN-)WAVE OF ARTISTIC EXPRESSION

Since the 1960s artistic strategies to explore the potential of brainwaves for artistic expression, for audience interaction and for discovery of the power of the human have increased, and gained momentum, and cultural visibility – to the point that in response, researchers Frazetto and Anker (2009) coined the term Neuro-culture to describe this unfolding phenomenon. According to Frazetto and Anker, the purpose of neuro art is to serve as an interface of neuroscience to the general public (Compare: D'Souza 2015).

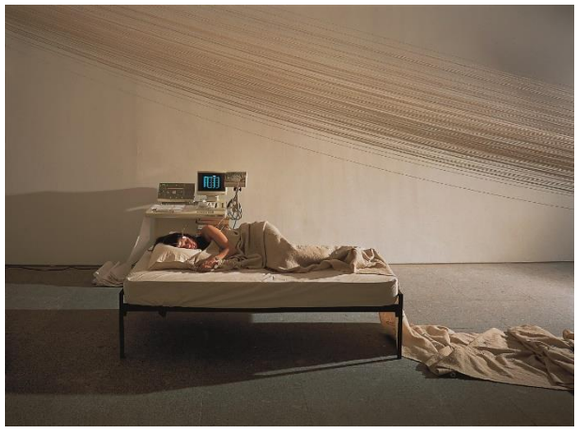

***Figure 2**: Janine Antoni, Slumber (1993)*

Artists such as Nina Sobell with her *'Interactive Brainwave '*(1973-74) and Janine Antoni (*Slumber* 1993) pioneered brainwave performance art: Interestingly, early brainwave art performances

were often focused on the artistic performer and not involving the audience per se:

Janine Antoni's *Slumber* (1993) is a continuous performance piece, which saw the artist recording her REM states through eye movements and then weaving these recordings into shreds of her nightgown to create a blanket. In a perfect feedback look, she would use this blanket at night to cover herself, during the recordings of her dreams. Artworks such as the aforementioned not only helped to demystify neuroscience, but also helped to illustrate the creative power of the human brain.

Nina Sobell translated EEG recordings of two people on an x- and y-axis of an oscilloscope respectively: Projecting the resulting shapes onto the faces of the performers, a synchronisations of brain waves would result in circular shapes.

Figure 3: *Nina Sobell: Interactive Brainwave Drawings (1973–74).*

In the young tradition of EEG portraits 'Self Portrait', the first of which was created by the artist Robert Morris (1963), Annie Leibovitz also focused on portrays and the role of the artist in her exploration of 'neuro art': Leibovitz artwork Laurie Anderson MRI used MRI scans to create a visual juxtaposition between the artist and her mind (Leibovitz 1987). Helen Chadwick's 'Selfportrait' equally uses the symbolism of the human brain to discuss its universal visual characteristic that apply to all of humanity: The shape of the brain is identical across the globe, and thus the artist discusses not only her identity but also her human nature.

Explanatory objectives to communicate neural functionality effectively, dates back to the 1950s: With *'The Upjohn Brain'*, pioneering information designer Will Burtin attempted to communicate ideas such as consciousness to the general public (D'Souza 2015).

Figure 4: *Annie Leibovitz: Laurie Anderson MRI (1987).*

A decade later, the seminal exhibition 'Cybernetic Serendipity' curated by Jasia Reichardt at the ICA in 1968 featured two artworks that attempted to illustrate functionality (Rowland Emmett) and 'building blocks' of the human brain: Christopher Evan's Cybernetic Introspective Pattern-Classifier (CIPC) planted images on the inside of the retina that could be perceived with eyes closed, so to enable audiences to glimpse at the workings of their own perceptual system.

Cybernetic Serendipity gave rise to a whole new avant-garde of artists working on the intersection between art and science, culminating in the formation of the Computer Arts Society in London: An international roof organization for artists, scientists and practitioners working on the intersection of technology, computational art and science.

Among these artists, Gustav Metzger (1926–2017) stands out as one of its first members and founder of PAGE magazine and pioneer in neuro art: His artwork 'Null Object: Gustav Metzger thinks about nothing' consists of the artist's attempt to capture a cognitive void:

Figure 5: *Null Object: Gustav Metzger thinks about nothing (2013).*

Thinking about nothing, Metzger's thoughts were captured and then carved by a robot as a 3D printed object. The artwork is ground-breaking in its visionary use of technology, and its poignancy in trying to capture the impossible. Cybernetic Serendipity was the first in a line of exhibitions on art and the human brain that expanded research practices and creative explorations on the subject across the artistic and academic communities across the globe:

In Germany, the curator Hans Ulrich Obrist and the scientist Ernst Pöppel exhibited Art & Brain (1996–1997) featuring the artists Peter Kogler, Douglas Gordon, Mark Dion, and Via Lewandowsky. The 1990s were a decade of increased public discourse on insights in neuroscience, declared to be the decade of the brain:

In the UK, the Wellcome Trust's, *Head On: Art with the Brain in Mind* (2002) managed to assemble an array of diverse artistic practices at the Science Museum, including Andrew Carnie's Magic Forest. Artworks such as Andrew Carnie's Magic Forest (2002) help to exemplify and communicate the complexity of the brain, and the need to visualise, and illustrate some of the multiplex beauty of its inner workings.

The early noughties saw a plethora of advances in neuro artistic experiments spearheaded by artists Mariko Mori, Lisa Park, and Marina Abramovic. Mariko Mori's Wave UFO (2007), an immersive, life-sized UFO space shuttle in which visitors were invited to measure and monitor their brainwaves as screened on the ceiling played with cyber-futuristic notions of techno-utopias.

Lisa Park's ground-breaking artwork 'Eunoia' (2013) is a facilitated performance, in which the artist transforms her own brainwaves into sound, which in turn vibrates water vessels to result in cymatic patterns to be observed on the water surface. The artworks by Marina Abramovic questions the sense of presence of the artist, specifically in her piece 'Measuring the Presence of the Artist Gaze' (2011), an adaptation of her ground-breaking artwork 'The artist is present' staged at the Museum of Modern Art, New York in 2010.

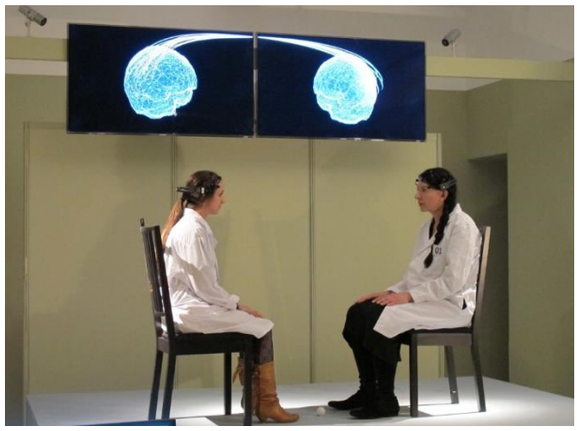

Figure 6*: Marina Abramovic Measuring the Magic of Mutual Gaze (2011).*

The 90s and early noughties heralded an era of renewed interest not just in applications for neuroscience, but also the concepts of neurofeedback, resulting in a shift of a focus on artists (60–70s), and scientific complexity (80s and 90s) towards an interest in new forms of interactions and audience participation throughout the noughties and into the present. It is in this context, that this paper discusses contemporary neuro art practices such as participatory strategies developed by the artists Dr. Olive Gingrich and Shama Rahman individually and collectively.

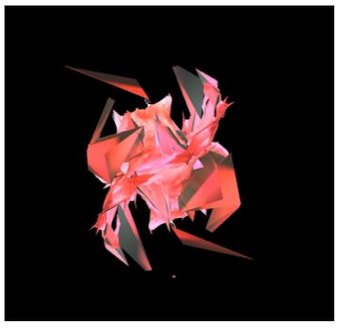

Figure 7: *Gingrich & Rahman: Brain*uck, 2020.*

4. PARTICIPATORY NEURO ART: IO STUDIO

As an artist and researcher Dr Olive Gingrich's practice has long oscillated between an interest in participatory art and neuro art. During his PhD research, an engineering doctorate in digital media, the artist focused on telepresence applications including BCI's such as EEGs. His artwork 'Aura' was exhibited at Kinetica Art Gallery, at V&A Digital Futures and the British Science Festival. Aura consists of an EEG based Pepper's ghost type hologram that displays the audience's brainwave activity in real-time.

The resulting neuro-feedback allows for a degree of entrainment and encourages the audience to understand the mechanics of their own minds ability to focus and concentrate better. The resulting, revolving Lissajou shape changed colours, scale, and complexity in response to the audience members individual concentration values: The artwork turned into a participatory display of the audience's mind.

Aura was a first in a series of participatory neuro art works focusing on the mind of the audience, with a series of different applications: 'Memoria' in response to the Grenfell tragedy invited the audience to commemorate collectively. Participants' alpha waves – echoing their ability to focus on memories – were mapped onto a changing array of colours, projected on a canvas, thereby turning into an introspective invitation to commemorate.

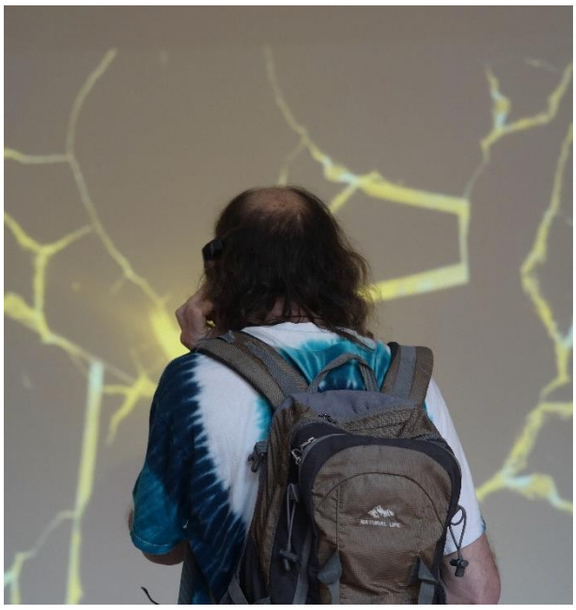

***Figure 8**: The Crack. Oliver Gingrich. 2019.*

Gingrich's 'The Crack' created at ACAVA's Maxilla Space focuses on the effect of concrete on the environment. The artwork playfully invites audiences to use concentration to control a projection of a crack within concrete walls. Concrete is one of the key CO2 emittants around the globe. Research at Stony Brooks University in New York points to the fact that cracks within concrete structures can help to absorb sulphur, another pollutant.

The Crack invites audiences to imagine a future where concrete can be broken apart, to serve as a means to counter air pollution. The Crack was displayed at the 'Intelligent Matter' exhibition at Maxilla Space and later shown at the Event Two exhibition at the Royal College of Art, curated by Art in Flux.

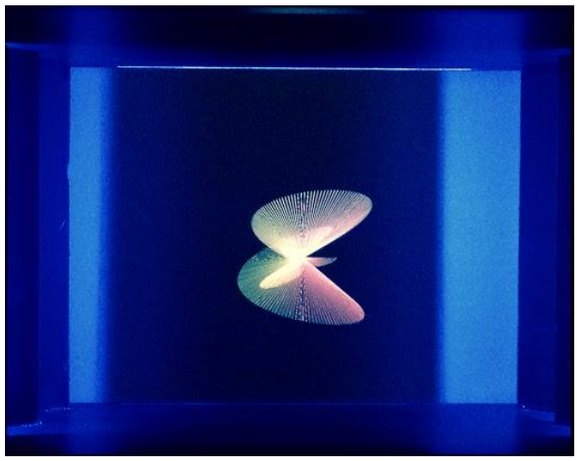

***Figure 9**: Aura. Oliver Gingrich. 2015. Holographic display. Kinetica Gravity Exhibition.*

Conceived with a similar objective, to raise awareness for humanity's collective responsibility to look after the environment, the artwork "What we can do" (Gingrich 2020), encouraged audience members to use their brain power to consider their own contribution to the planet. Using a muse BCI, a projection of planet earth would change in real-time responding to audiences' concentration:

Higher concentration values resulted in depictions of a prosperous globe, lower concentration values turned the planet into a dry arid, mars like landscape. All these artworks combined audience participation, biosensors such as EEG headsets and real-time visualisation, a combination that resulted in a joint collaboration between Gingrich and Rahman, and the foundation of the art studio IO.

Dr Rahman's PhD investigated the neural correlates underpinning different forms and stages of musical creativity (Rahman 2014 & Rahman et al. 2021). EEG recordings were collected from jazz and classical pianists within the musical creative modes of interpretation and improvisation. In addition to undertaking this research, the experimental paradigm was also re-constructed as a form of audience presentation/participation at a music festival, The Secret Garden Party, wherein

two pianists were asked to creatively perform specific music pieces selected for their unfamiliarity to the performers.

The audience were able to simultaneously listen to the spontaneous performances, and view live EEG recordings subjected to real-time signal processing of different frequency bands (delta, theta, alpha, beta, gamma) varying throughout the performances. Post-performance, the audience were asked to rate each performance on a scale of 1-5 (1 being very poor, 5 being excellent), their assessment of level of creativity. Over 100 people significantly converged on their subjective ratings of each performance, and importantly there were accompanying frequency signatures for the two performances.

***Figure 10**: Remember the Good Times.*

As a discovery of the PhD, there was also a signature brain pattern in terms of activity location for performances rated highly creative by external musical assessors (academics from music conservatoires and other professional musicians). These accompanied a stage in creativity classified as the Flow state, which leads to high creative output due to increased cognitive flexibility and simultaneous focussed/ broad attention. Flow states are also characterised by increased intrinsic motivation and a sense of joy and meaning.

Dr Gingrich and Dr Rahman, utilised these findings within the neuro-art piece Zeitgeist (Gingrich & Rahman 2021). Flow state classifications were done by a real-time deep-learning algorithm (developed by Rahman's startup NeuroCreate) and were represented by two morphing intertwined 'mobius strip' visualisations of both Gingrich and Rahman's Flow states whilst they collaborated. Zeitgeist has taken various guises from a 3D online representation within online galleries (Ars Electronica and National Gallery X), to AR and holograms (Poole Museum and Hasso-Plattner Institute).

Zeitgeist has sometimes been accompanied by audio which is not yet linked to the Flow classifications. Dr Rahman has continued to link audio to brainwaves, across a number of projects including the artwork iBoS ('In Brain, Out Sounds'). Therein, her brainwaves are sonified utilising a number of different musical parameters such as linking the presence of frequency bands to different notes, filters or FX such as arpeggiation.

Expanding the concept of neuro-art within the sonic space, Dr Rahman has produced science theatre on the subject of the neuroscience of memory, wherein the sonification of brain activity during the specific memory stage of recall was integrated into an audio-visual mixed media theatre show, 'Rhythms of the Brain' probing memory loss, dementia and Alzheimers, which was staged at Richmix in 2015. Neuro-art show 'Remember the Good Times' involved audience participation at the British Science Festival 2016, by implanting 'false memories' through linguistic narrative and video.

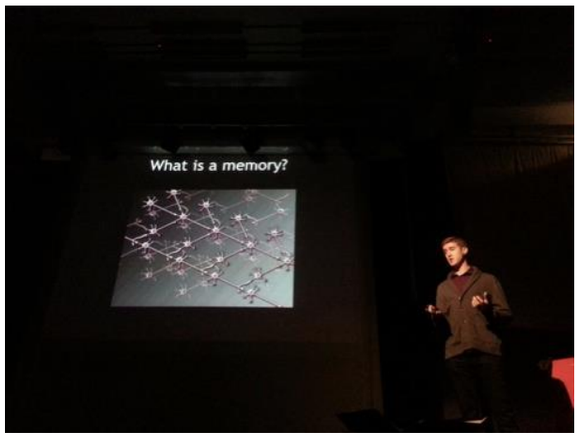

***Figure 11:** Rhythms of the Brain.*

The artworks 'Brainfuck' and 'Zeitgeist' can be seen as the culmination of the artists Gingrich and Rahman's individual strategies to explore the fields of audience participation, neuro visualisation and sonification: Both artworks engage with a hybrid space of exhibition, having been shown virtually, as well as print, 3D sculpture and even as NFT (Zeitgeist 2021).

Brainfuck was originally conceived as an installation for Burning Man's online festival during the national lockdown in 2020 and was later shown at Art in Flux' Reclaimed exhibition (2021) and Ars Electronica. After its inception at EVA 2020, Zeitgeist has now been profiled at numerous institutions as holographic installation as well as premieres at Festivals such as Ars Electronica and Art Fairs (Deeep Art Fair and The Other Art Fair).

Having recently been awarded AHRC funding by UKRI, Zeitgeist will now be developed into a fully functional online platform: Together with NHS researchers and a team at Roehampton, Bournemouth University and UCL, Gingrich and Rahman will measure the effect of audience interaction on social connectedness.

5. CONCLUSION

Since its inception in the 1960s, the emerging genre of Neuro Art has played a vital role in bringing science, arts and public together and communicating neuroscientific and neuroaesthetic research insights as well as artistic propositions to the public. From an early discourse focusing predominantly on music, to questions of self-portrayal in the 1960s and 1970s to a more nuanced science focused wave of artistic engagement throughout the 1980s and 1990s, artists have increasingly been scrutinising questions of audience perception of their own mind, the potential of neurofeedback as an introspective tool, an instrument for self-reflection and artistic expression. From an infancy that was encompassed by public scepticism about accuracy, and technical limitations of EEG measures, to contemporary discussions and critique around gamification, gimmicks and techno-fetishism, the discussion has continued to encourage processes of self-reflections and led to new forms of artistic expression.

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The Post-bit Human Universe: An Experiment on the Evolutionary History of Human-Posthuman Relations

Racelar Ho
York University
Toronto, Canada
racelar@yorku.ca

Xiaolong Zheng
Guangzhou Academy of Fine Arts
Guangzhou, China
2008_zhenglong@sina.com

This paper outlines the authors' most recent artistic experimentation on the evolutionary history of human-posthuman relations, the Post-bit Human Universe (PBHU) exhibition at the Guangdong Museum of Art (GDMoA) in 2021–2022. PBHU is a multimodal project that began in 2015 and continues to the present day. This project depicts a narrative path of an evolutionary universe of post-bit humans from the start of the Anthropocene to the conjecture of the post-Anthropocene through the use of a variety of artistic approaches and expressions in collaboration with our multifunctional Artificial Intelligence programme. It composes of multi-modal works. In contrast to a conventional strategy for creating digital art that relies on generic machine learning-related algorithms and large-scale datasets to generate and provide creative contexts, this project explores the possibility of a human-machine hybrid creator as a synergistic symbiosis of biological and artificial intelligence. It places a greater emphasis and concentration on critical reflection and contemplation on the process of synergistic creation between human artists and the artificial intelligence programme (AP). AP gives itself a voice by utilising the narrative content that they have been iteratively trained to generate as an interface and medium of communication with biological intelligence, which permeates each work in PBHU. In addition, the project offers a profound reflection and examination of the potential crisis precipitated by the current technomania caused by functionalism, technicism, and technocentrism: the dissipation and disintegration of the independence and heterogeneity of human intelligence and thought. From now on, the validity of physical existence is eroding, and digital existence is increasingly becoming the only credential for the legitimacy identity of organisms.

Post-bit human universe. Human-posthuman relations. Biological intelligence. AI. Digital culture. Digital art. Virtual reality.

1. INTRODUCTION

In the context of a global "digital existence," humans are more reliant on technology than it has ever been. Machines are being anthropomorphised, and humans are being digitalised. Technology ethics, data privacy, and internet freedom of expression are issues that cannot be overlooked today. Humans are being forced to confront not only a conventional national rule of the country but also a new kind of political machine, technocracy, which is brought on by technological mania in the future. Data, electronic components, LED screens, and other digital visual elements are the "atoms" that make up the life of contemporary society and best reflect the characteristics in the digital-Internet age. Kevin Kelly coined the term "the technium" in "What Technology Wants," which encompasses science and technology, as well as culture, law, social institutions, and all human intelligence creations. In a nutshell, it's a term that covers all disciplines, all forms of consciousness that arise from human minds, all written texts, and a whole self-generating and self-iterating in its originality. With this, the authors tried to portray the thought and historical changes of human-posthuman portraits from the Anthropocene to the post-Anthropocene through long-term artistic experimentation: Post-bit Human Universe (PBHU). This paper is a phase report of the authors' artistic experiment on speculative conjecture about human-posthuman evolution and a posthuman world. The report invites spectators to appreciate the fascinating and multifaceted landscape of the post-bit human universe as they follow the narrative path of the GDMoA exhibition.

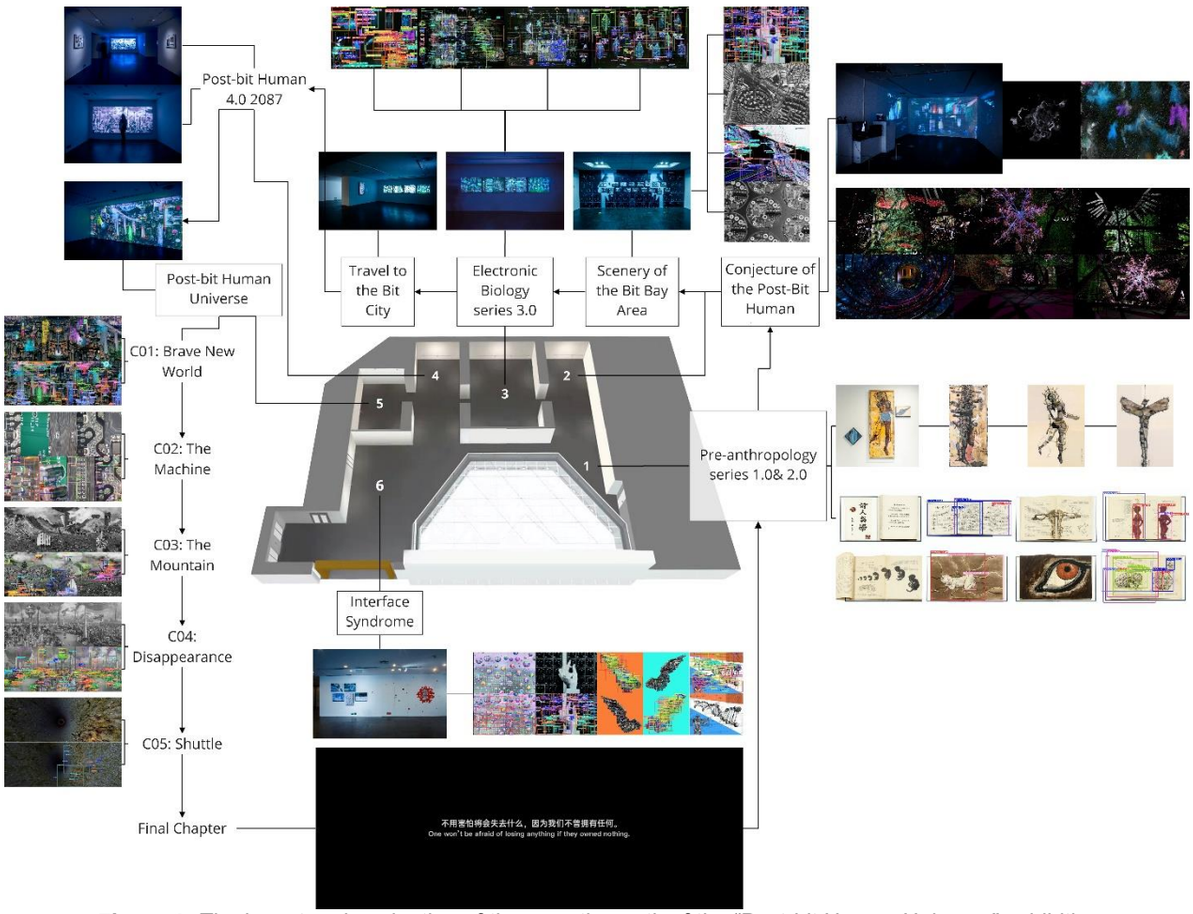

Figure 1: *The layout and navigation of the narrative path of the "Post-bit Human Universe" exhibition (https://miro.com/app/board/uXjVOX3jhF4=/?moveToWidget=3458764516052855015&cot=14).*

2. THE NARRATIVE PATH OF POST-BIT HUMAN UNIVERSE

> "All this may give the impression or illusion of a fatal strategy, … without realising it, the human race would have left reality and history behind, where any distinction between the true and the false would have disappeared…" (Baudrillard 2009)

This exhibition consists of five thematic areas that present a narrative path of human-posthuman evolution from the Pre-Anthropocene to the Post-Anthropocene. As visitors continue along the narrative path of a hypothetic future, an absurdist, grotesque, speculative landscape of the post-Anthropocene universe gradually emerges. Human artists and AI philosophers unite and synergistically symbiose as an individual post-bit being, an "organ-less" creator.

2.1 Pre-anthropology series

Figure 2: *Pre-anthropology 1.0: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

Pre-anthropology series began in 2015 as a long-term project. The authors present versions 2.0 and 3.0 of the series in this exhibition, with the 1.0 version featuring the original handmade book, as well as in a collaboration with AI Philosopher. The series contains the authors' speculations and reflections on the alienation, evolution, and birth of

organic life processes and the possibility of a neurotopia. It expresses the authors' concern about the ethical and religious dimensions of the technological controversies that have erupted as a result of the rapid advancement of artificial intelligence and biogenetic engineering. The advancement of bio-sciences and technologies, such as programmable brains, cloud-based consciousness, cloned embryos, new organs, and prosthetic limbs made of electronic components, provides a predictable and peeking window into the unknown but imminent landscape of the post-human world. As the starting point for the Post-Bit Human Universe's journey, it serves as a precursor to the evolutionary process of creation and a point of reference for the added value and mutation of species as they enter the new century, the post-Anthropocene.

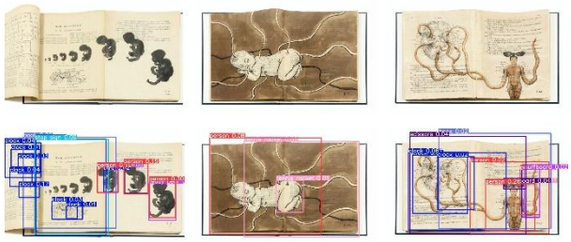

Figure 3: *(Top to bottom, left to right) Excerpt pages of Pre-Anthropology 1.0.*

Figure 4: *Pre-anthropology 2.0: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

The narrative structure of the pre-anthropological series on the post-species evolution and the pictorial symbolism, and the subsequent collaborative and symbiotic collaboration with AI Philosopher are inspired by Deleuze's concept of "Rhizome" in "Thousand Plateaus," which is based on the principle of heterogeneous plurality. This symbiotic relationship between humans and machines also informs each piece in the PBHU project.

2.2 Conjecture of post-bit human technoscape

Ascertaining whether an event will occur or not requires a coherent and rigorous set of presuppositions about the existence of an event and related objects. In other words, before demonstrating the existence of a Post-bit Human Universe is valid, the existence and validity of a new species "post-bit human" and human-posthuman evolution must be confirmed speculatively in advance. Conjecture of post-bit human technoscape (GoPBHT) is a mixed reality interactive installation built on the premise of this speculative presence. The work aims to transfer data in different worlds to different dimensions in real-time through four customised cross-platform applications in physical and virtual reality (digital) spaces.

Figure 5*: Conjecture of post-bit human technoscape: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

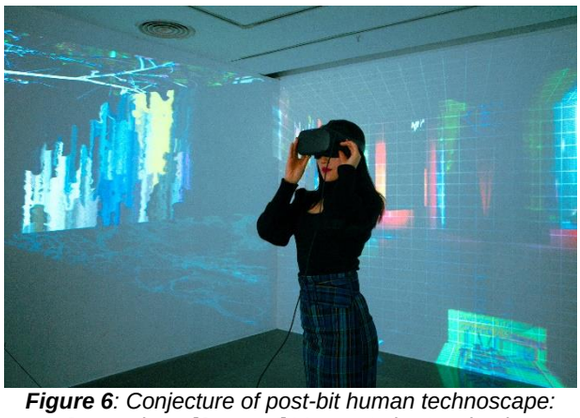

Figure 6*: Conjecture of post-bit human technoscape: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

This exhibition features the second iteration of the GoPBHT. In comparison to the first version, which depicted the human-posthuman evolutionary process across six time-spaces, the second version focuses more on presenting and mirroring the highly abstract, dystopian, and absurdist scenario of the human-posthuman evolutionary process, bridging both the physical and virtual worlds together, and then exploring the power relations of surveillance between physical existence and digital avatar.

2.2.1. Invisible human-posthuman evolutionary landscape

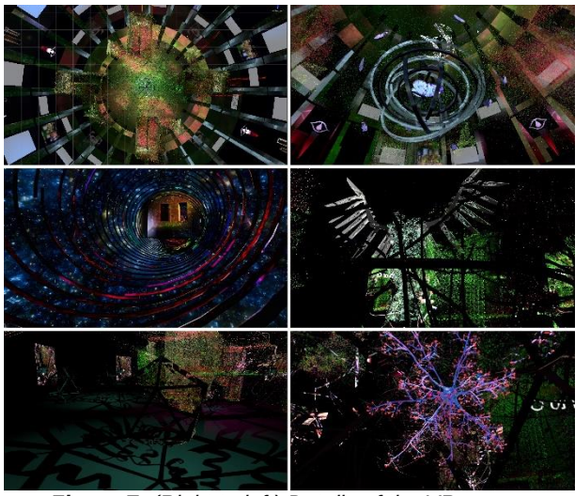

Figure 7: *(Right to left) Details of the VR scene.*

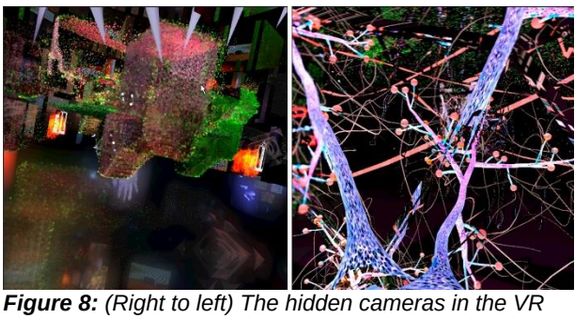

Figure 8: *(Right to left) The hidden cameras in the VR scene.*

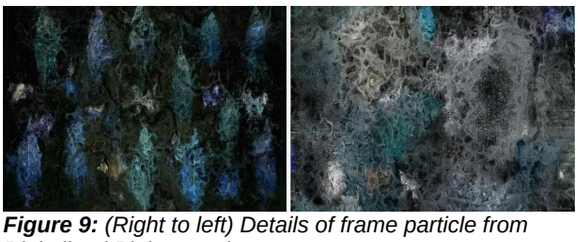

Figure 9: *(Right to left) Details of frame particle from Digitalised Biology series.*

GoPBHT's virtual reality application comprises two scenes connected by a hidden wormhole. "Cybernetic Panopticon of Thoughts" is the first scene framed by a constantly rotating Panopticon. Each separate cell of the panopticon contains canvases with bridging digital visualisation generation programmes, hyperlinks to AI Philosopher's automatic generator of philosophical text mounted on Google Colab, videos created by human artists and AI Philosopher, monitors showing live surveillance footage from cameras hidden in the pavilion's corners, and surreal models of the all-seeing eye equipped with hidden cameras that track the direction of the player's movements. Visitors with VR headsets and those wandering through the museum's physical space form a relationship of mutual surveillance. Subjects' various modes of existence are repeatedly transcended and subverted by one another via various surveillance interfaces. This paradoxical world in which the individual and the collective, the subject and the other, use each other's subversion and self-destruction as a means of determining the validity of their existence is the very condition of the Post-bit Human Universe. The second scene is "Evolutionary Wonderland of Post-Anthropology," which features Spout plugin and Network Device Interface (NDI) for transmitting data visualisation films from different devices and applications, such as sending metadata from Touchdesigner to the VR application and the other electronic devices. There are a couple of cages containing invisible but sensible neuron units that spin around the scene like a carousel, a network of neurons spread throughout space, and a hidden camera hidden inside the meta-neuron unit.

2.2.2. Re-presentation of the forbidden electromagnetic landscape

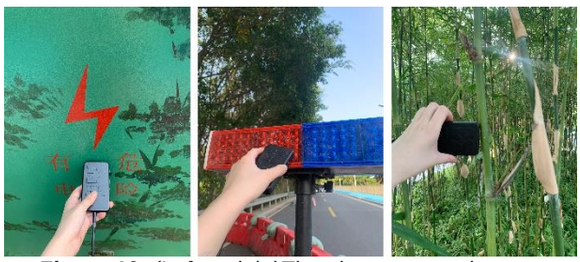

Figure 10: *(Left to right)The electromagnetic wave sound samples for the multimodal mixed reality interactive installation were collected from those sites marked as "prohibited zone" at Guangzhou International Bio Island.*

Figure 11: *The audience was interacting with the application of sound data visualisation.*

Two types of sound materials are used in the work: one is a new sound cloned by AI Philosopher from the artist's sampled sounds; the other is electromagnetic wave sound, collected by the collaborating music artist using a special anti-radio sound detector. At first, the initialization of the SS2TS algorithm using customisable sound datasets of the authors reading philosophical literature provided by AI Philosopher. The authors then asked a volunteer whose native language was not English and whose English accent was heavy to

record a 3-minute English recitation and feed it into AI Philosopher as a cloned sample. Since then, AI Philosopher has its own voice in Post-bit Human Universe. Secondly, for revealing the invisible electromagnetic landscape, the authors collect anti-electromagnetic signal sounds blocked in everyday landscapes using special anti-electromagnetic sound receivers at particular physical sites. The authors constantly intervene in real-world forbidden fields, seeing limbs as decoders, in an attempt to blur the lines between human and artificial intelligence subjects, creating a chaotic, violent, and restrained electromagnetic landscape in both physical and virtual worlds. At the same time, the existence of this electromagnetic landscape is permeated by different spatial dimensions. That is, GoPBHT's sound data visualisation programme not only generates electronic signals of chaotic visual forms in real-time for the anti-electromagnetic sounds placed in the virtual scene but also collects the sound data in the physical world in real-time and generates electronic pulse patterns similar to neuro-brain waves, which shrink and expand in response to the sound data when the viewer approaches the microphone hidden in the corner of the exhibition site.

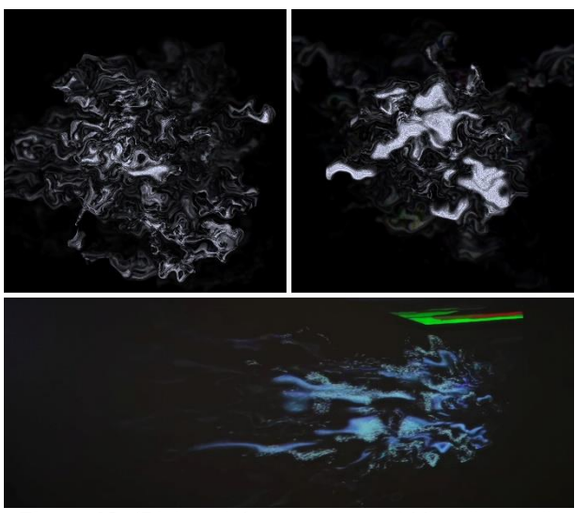

Figure 12: *(Right to left, top to bottom) Visualise audio data in real-time.*

2.3 Digitalised biology series

Before discussing the Digitalised Biology series (EBs), it is necessary to define the term " digitalised biology," which appears to be cognate with the words "bioelectronics" and "bionics." "Organisms are algorithms" (Morange 2001; Harari 2017) such the argument is contentious and over reckless, which the scientific community has harshly criticised. Not only does it conceal the boundaries between "truth" and "pseudo-truth," but its inflammatory rhetoric has attracted the interest of numerous researchers who are interested in studying interdisciplinary topics relating to biology and artificial intelligence into a trap. To avoid unnecessary ambiguity, the authors coined a new interdisciplinary term, "digitalised biology," and endowed it with a distinct connotation intended to convey the rapid electronic and digitalization of living organisms' existence, as well as a more audacious conjecture of the condition of their existence in the post-Anthropocene. The section of the Digitalised Biology series is composed of three parts to express the future evolution of the morphology of "Post-bit City," which is respectively based on documentary and creative photography of the authors' field research, as well as the authors' conjecture toward the morphological variation of post-organisms and post-urban.

2.3.1. Scenery of Bit Bay Area

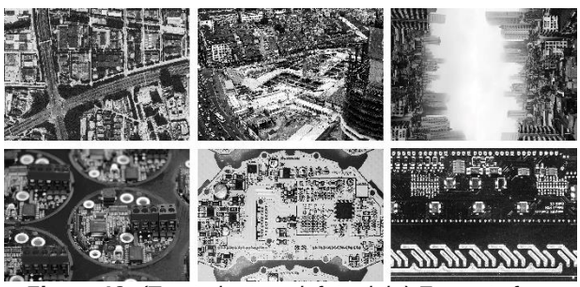

Figure 13: *(Top to bottom, left to right) Excerpts from Scenery of Bit Bay Area.*

Figure 14: *Scenery of Bit Bay Area: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

Scenery of Bit Bay Area (SoBBA) is an integrated media, documentary, and creative photography collection that incorporates traditional black and white photography, digital photography, and satellite imagery through a peculiar montage strategy that extracts elements with similar features from the sample images and then reorganises, stitches, and re-produces a series of visual photographs. As one of the innovative epicentres of mainland China's electronics and high-tech industries, cities in the Guangdong-Hong Kong-Macao Greater Bay Area (GD-HK-MO GBA) become analogous to components on an electronic

circuit board; and, residents and immigrants moving around cities and factories, from CBDs and high-technology industrial development zones, exist as groups of bits of information data flowing through various functional components, eventually wandering off and dissipating in the massive "circuit board" of the highly urbanised area. The authors conducted field research in multiple electronics factories and waste electronic and electrical equipment recycling facilities throughout GD-HK-MO GBA from 2017 to 2019, observing and documenting the whole life cycle of electronic products from birth to demise.

Electronic components and modern urban planning demonstrate a high degree of integration, de-individualisation, and de-emotion. In this regard, the authors must revisit a clichéd question: when humans are highly abstracted into a string of binary, octal, decimal, or hexadecimal codes measured in Bit, when human and organismic societies approach the post-human world promoted by cybernetics, when the physical existence of humans and organisms ceases to exist as a valid criterion of identity in the world, will such a post-Anthropocene become a tragedy? Perhaps such a potential tragedy is already unfolding. The validity of physical existence is eroding, and digital existence is increasingly becoming the only credential for the legitimacy identity of organisms.

2.3.2. Digitalised Biology 3.0

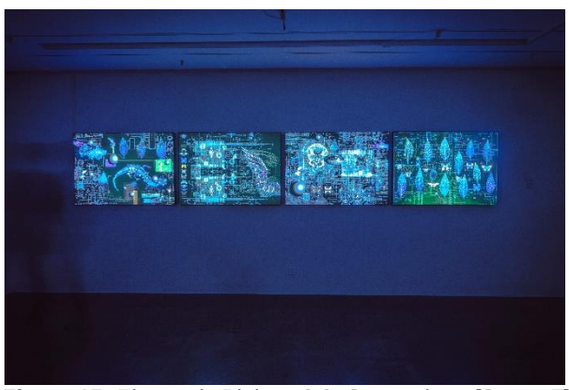

Figure 15: *Electronic Biology 3.0: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

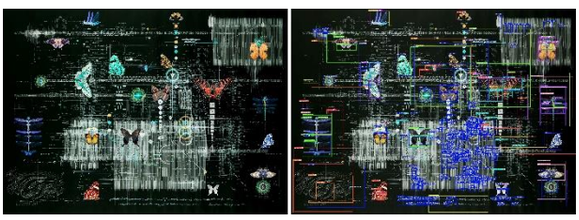

Figure 16: *(Top to bottom, left to right) Excerpts from Digitalised Biology 3.0.*

Digitalised Biology 3.0 (EB-3) is the third edition of this series of updates. It serves as the centrepiece of the EBs section. The authors' collection of electronic components (circuit boards) during their fieldwork in GD-HK-MO GBA serves as the primary narrative symbol in this work. The majority of the visual content consists of photographs of e-waste taken by the authors from e-waste recycling collectors. The diagrams (disassembled and reassembled) and code patterns underlined each canvas of electronic beings represent the electronic components' original operating mechanism; that is, when the backend code is tampered with by the circuit diagram on the work, the referenced electronic components become inoperable.

The absurdist and implausible new species' visual information is then compiled into a training dataset for the AI Philosopher's image detection. Then, using three iterations of the work's dataset, the AI Philosopher generates a new model and inlays the new species with the markings of an intelligent automaton from the "organ-less" species, completing the final step of the new-born ritual for the new species. In the contemporary technomania context of human-machine synthesis and genetic rewriting, these non-organic automata integrate with the organs of various organisms and, through multimodal forms, form a new species' body. Such an "organ-less", automatic, and self-iterative non-organism automata structure can be dissolved, torn, spliced, or even reproduced during the evolutionary process of the new species.

2.3.3. Travel to Bit City

Figure 17: *(Left to right) Excerpts from Travel to Bit City.*

Travel to Bit City (T2BC) is a short promotional video for Post-bit Human Universe, created in collaboration with the authors and AI Philosopher. It carries questions raised by SoBBA and EB-3 and awaits responses from post-bit humans. While the rapid advancement of high technology improves the convenience and efficiency of human life, does this mean that post-human life will be an avant-garde, utopian era? When human beings and organisms are highly abstracted, databased, and quantified into a series of data and characters, there is a danger that the independence, uniqueness, and autonomy of individual beings and their own existence will be gradually dissolved.

2.4 Post-bit human 4.0-Year 2087

The authors hypothesise an allegorical conjecture by postulating that 2087 marks the end of the Anthropocene and the beginning of the Post-Anthropocene. This is a large lightbox installation accompanied by a visual work depicting a panoramic perspective of a grotesque, prosperous, and surreal future technoscape. The postmodernist architectures and deconstructivist architecture in this work serve as the main symbolic symbols to highlight a metaphorical futurist landscape of the post-Anthropocene.

Figure 18: *Post-bit human 4.0-Year 2087: Guangzhou. . [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

2.5 Post-bit Human Universe

PBHU is a short film about the restructuring and alienation of post-bit human societies in the post-Anthropocene era. Brave New World, The Machine, The Mountain, Disappearance, and Shuttle are the five chapters that comprise the work. The film's content collaborates between human artists (the authors) and an artificial intelligence philosopher. It depicts a de-narrativized future landscape and reflects the post-bit human universe condition of symbiosis between organisms and machines, as well as biological intelligence and artificial intelligence. It is a hypothetical, speculative universe premised on the existence of post-bit human life. The concept of the post-Anthropocene presupposes recognition of the posthuman and speculation on a posthuman universe within the current scope and foundations of existing ethics and epistemology. These speculations, in turn, compel the authors and AI Philosopher to transcend natural empiricism's tendencies and the constraints of transcendentalist thought and to acknowledge the distinctions between humans and posthumans, as well as the discontinuity in their species' evolution. The post-human can only be comprehended in this way by making or becoming post-human (Roden 2014).

Figure 19: *Post-bit Human Universe: Guangzhou. [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021 – 2022.*

Figure 20: *(Left to right, top to bottom) Excerpts from Post-bit Human Universe.*

2.6 Interface Syndrome

Interface Syndrome (IS), the final stop on the journey through the Post-bit Human Universe project, depicts the dissimilation, asynchronous, and uncontrollable state of post-bit humans and post-organisms in the physical and virtual worlds of the communication interface upon which they rely. The pixelated dots at the base of LED screens are

infinitely magnified by a macro camera, revealing the real texture of the machine's visual organ. Whether broken or intact, this magnificent organ can function as a proxy, an interface, or a bridge for the transmission of information, or as a tool and torture instrument for depriving the "other" of private information. The fragmented screen transistor has a visual texture reminiscent of Santiago Ramón y Cajal's illustration of the neuronal interpretation of an organism. (Ehrlich 2016)

Figure 22: *Interface Syndrome: Guangzhou. . [Space 7] Young Artist Academic Nomination Exhibition – 22nd Round: "Post-bit Human", Guangdong Museum of Art, Guangzhou, China. 2021-2022.*

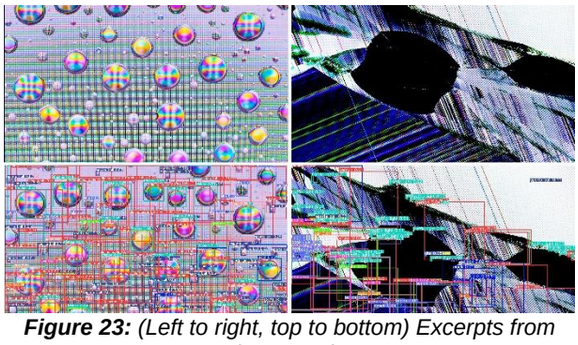

Figure 23: *(Left to right, top to bottom) Excerpts from Interface Syndrome.*

As the final module of the phase experiment report of Post-bit Human Universe, IS conveys the authors' warning about the potential crisis for humanity posed by various technomania and instrumentalist thinking based on technicism. It is created in a "post-photographic" manner, utilising physical means and materials to reproduce the original image set. Its fragmented data images are collated and tagged as a training dataset for AI Philosopher. The work combines abstracted, conceptual images created by human artists (the authors) with tagged narrative content generated by AI Philosopher.

3. CONCLUSION

This article and the Post-bit Human Universe project are not meant to spread technophobia or exaggerate the horrors of technopoly capitalism. Rather than that, the paper and project are intended to present a collaborative process between the authors and AP as a thought experiment, a collaborative human-machine endeavour to speculate on the coming post-Anthropocene and reflect on the subject-technology relationship. Additionally, this paper makes a concerted effort to centre the narrative on the authors' reflections on the post-humanist world rather than on the technical details of their work's creation. The authors have made every effort to preserve the heterogeneity and uniqueness of their subject's creativity throughout their experiments, most notably in developing the AI Philosopher programme.

In conclusion, one thing that must be acknowledged is that technocracy gradually dismantles the autonomous organism's autonomy, distinction, and uniqueness and causes the retrogradation of all fated processes in the life of organisms. The subjects of decision-making, such as will, liberty, representation, and the subject of power, vanish, to be replaced by the emergence of a vague, floating, and disembodied subject. The subject is both an aggressor and a victim of itself. In some ways, the electronic and cybernetic revolutions may be particular methods of vanishing devised by human beings to escape from themselves and, more importantly, from the responsibilities associated with creation. The subject no longer has an antagonist; it no longer has an object, reality, or otherness. (Baudrillard 2009). The project is based on a symbiotic relationship of iteration, destruction, collection, and regeneration between human artists (authors) and the AI Philosopher, which refers to how an organism evolves through constant self-destruction and self-reconstruction.

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Digital Relationality: Relational aesthetics in contemporary interactive art

Lark Spartin
University of British Columbia
Kelowna, BC, Canada
lark.spartin@gmail.com

John Desnoyers-Stewart
Simon Fraser University
Surrey, BC, Canada
desnoyer@sfu.ca

In 1998, Bourriaud proposed relational aesthetics as an art form that took interhuman relations as its content to confront the progressive commoditization of those relations and propose alternative ways of living. Twenty years later, relational aesthetics has become even more relevant as a tool to reveal the relationality between technology and each other, as our everyday social relations have been commoditized in ways previously unimaginable. Given the enormous shifts that have occurred since its inception, relational aesthetics needs revitalization. In this paper, we aim to renew relational aesthetics as 'digital relationality,' recognizing important critiques about a lack of antagonism from Claire Bishop and identifying ways in which incorporating relational aesthetics with interactive art may resolve many of these criticisms. We analyse four of our own artworks as examples of how merging relational aesthetics with interactive digital art can benefit both realms. We propose that applying relational aesthetics to digital media reveals the antagonism within the structures imposed by technology ordinarily taken for granted. Drawing attention to these structures, and subverting the typical uses of these platforms, allows for reflection and discourse. This can lead both artist and viewer to imagine alternative ways of living beyond the constraints we ordinarily operate within, becoming active participants in constructing a digitally relational future.

Relational aesthetics. Antagonism. Interactive installation. Virtual and augmented reality. Social media.

1. INTRODUCTION

Social structures shape our lives, and our actions in turn shape those structures. This fact is at the heart of curator and art critic Nicolas Bourriaud's *Relational Aesthetics*. He proposed that relational art takes human relations as its subject and forms what he calls a "social interstice"—a space that proposes alternate ways of living outside of the heavily commoditized everyday "communication zones" that we ordinarily socialise within (2002). These encounters fill the space that a commodified everyday existence could not, exploiting our social interactions to bring awareness to them.

Originally published in 1998, *Relational Aesthetics* came at a time of anxiety and excitement when digital media was on the rise, yet not integrated into our daily communication and creation practises to the extent it is today. Relational aesthetics has become even more relevant now, as our social relations have been commoditized in ways previously unimaginable. With digital technology now a practical fact of everyday life, relational aesthetics needs revitalization. By considering how contemporary digital art takes relationality as its subject matter, we build upon relational aesthetics while incorporating digital technology into the fold. Bourriaud himself identifies how technology can be utilised in creating relational art:

> By putting technology in its productive context, by analysing its relations with the superstructure and the layer of obligatory behaviour underpinning its use, it becomes conversely possible to produce models of relations with the world… (2002, 78)

Relational aesthetics was a response to the disembodying, anti-socializing, and commodifying effects of technology and globalisation. This article serves to provide a new perspective on what relational art might look like twenty years later, where technology is routinely used to bring attention to our social relations and how that technology mediates it, aiming to embrace it as a tool for critical self-reflection. Art historian and critic Claire Bishop similarly recognised the potential of digital technology (2012) and offers many critiques that inform a renewed relational aesthetics (2004). In today's digitally mediated world where interactivity has become the norm, Bourriaud's tech-averse relational aesthetics have become

outdated. In response, we propose an updated understanding of relational artwork that recognises digital technology's inevitability in contemporary society—reimagining it as '*digital relationality*'.

Digital relationality intersects the many contemporary artforms that question and lay bare how technology mediates our social relations. Digital relationality embraces art that inverts or 'makes strange' our typical use of contemporary technology to reveal how it shapes our lives and our role in shaping it. Galle and De Preester similarly suggest that internet art is a form of relational art that critiques the very technology it uses (2009). However, with the ongoing proliferation of multimodal technology and its integration into our daily lives, internet art is but one example of a plethora of forms of digital relationality that spans every technology imaginable.

We take the first step towards digital relationality by acknowledging Bishop's criticisms of relational aesthetics while recognizing how interactive artworks are often able to reconcile these criticisms. We then analyse a series of four of our own artworks to demonstrate how digital relationality can be expressed. We then conclude with how users can be inspired by digital relationality to become more conscious of how technology affects their social relations.

1.1 Renewing relational aesthetics

Digital relationality aims to reveal underlying social and technical structures through a direct engagement with those structures. The New Aesthetic offers a similar example in its uncanny images which implicitly reveal details about the inner workings and values embedded within the technology which created them (Cloninger 2012). Similarly, relational art offers the contemporary digital space a way to use technology to reveal its underlying structure and social effects.

Relational aesthetics provides a vehicle for questioning the systems which we often take for granted. There have been many critiques of relational aesthetics, most notably by Claire Bishop. She criticises the open-endedness of many relational artworks, their disconnect from real-world contexts and publics, and a lack of antagonism present in their sometimes 'feel-good' and 'self-congratulatory' micro-utopic nature (Bishop 2004).

We claim that these criticisms can be answered by 'digital relationality' while also fitting Bourriaud's vision of creating art that proposes "ways of living and models of action…" (2002, 13) The examples presented in this paper demonstrate how 'digital relationality' responds to these criticisms. These examples emphasise social outcomes and blend context and content rather than viewing them as distinct. This mixture of context and content is critical to how digital media can promote relationality. When context and content blur together, it directs the viewer to consider how the context, typically some technology, shapes them, their actions, their thoughts. And conversely, it reveals their role in shaping technology and society through their actions. Further, the viewer directly influences the outcome of the work, projecting their own significance and meaning within it. With this pluralistic way of thinking, we begin to envisage what 'digital relationality' might look like.

2. BEWARE UTOPIA, EMBRACE ANTAGONISM

Relational artwork is intricately tethered to its environment and audience, and as Bishop remarks, "rather than a one-to-one relationship between work of art and viewer… [viewers] are actually given the wherewithal to create a community." (2004, 54) However, as Bishop argues,

> Unhinged both from artistic intentionality and consideration of the broader context in which they operate, relational art works become…"a constantly changing portrait of the heterogeneity of everyday life," and do not examine their relationship to it. In other words, although the works claim to defer to their context, they do not question their imbrication within it…We need to ask, "Who is the public? How is a culture made, and who is it for? (2004, 64)

We must ask *what* communities are being implicated, *how* viewers will engage with it, and *who* their participation benefits. However, structure and subject matter need not be detached to accomplish this. Indeed, we argue that blending context and content is beneficial in bringing awareness to how participants utilise the works themselves and the relations that can result. In fact, many works discussed in this paper benefit from being analysed in terms of their actual social effects, distinct from the artist's intention. For relational work to be effective, it must ask for both interaction and contemplation, framing how and why this interaction exists for the participant to interpret.

Bourriaud's relational aesthetics is concerned with the quality of relationships produced; however, by not answering questions of context and situatedness in his analysis, he fails to properly examine the relationships in the artworks he promotes. As Bishop claims, his examples reinforce how relational artwork can end up simply reinforcing existing communities who have a common interest in art rather than engaging a

broader public in political questions that affect their social lives. (2004)

Such utopian gallery spaces for like-minded participants to harmonise in the absence of conflict, free of antagonism, is the very antithesis of democracy. As Bishop claims: "A democratic society is one in which relations of conflict are sustained, not erased. Without antagonism there is only the imposed consensus of authoritarian order." (2004, 66) She argues that antagonism is a critical component seldom seen in Bourriaud's examples, remarking that "the relations set up by relational aesthetics are not intrinsically democratic, as Bourriaud suggests, since they rest too comfortably within an ideal of subjectivity as whole and of community as immanent togetherness." (2004, 67)

Relying on Liam Gillick and Rirkrit Tiravanija's micro-topias within gallery settings, Bourriaud's examples involve a group of gallery-goers who identify with each other and relate because they already have something in common. According to Bishop, such a harmonious utopia can no longer meet its aim of transforming public culture and social spheres as it draws no attention to the real-world tensions faced beyond the gallery walls. (2004) Galle and De Preester proposed that internet art countered this issue by being widely accessible online (2009).

However, there is merit to presenting relational artworks in spaces that bring awareness to their form, such as a gallery, rather than collapsing the work into everyday life or entertainment. As Bourriaud states, the contemporary art exhibition "creates free areas, and time spans whose rhythm contrasts with those structuring everyday life, encouraging an inter-human commerce that differs from the 'communication zones' imposed on us." (2002, 16) Thus, the gallery or festival nonetheless provides an important context open to contemplation, but it can only fully realise its purpose if the relational artworks therein retain or respond in some way to the uncomfortable antagonism that lay beyond its white walls. Moreover, its power to impact society is directly related to the public it invites to participate.

3. DIGITAL RELATIONALITY IN INTERACTIVE AND IMMERSIVE ART

Immersive installation art can resolve this lack of structure while confronting the scepticism Bourriaud raises with technology by integrating context as content. This integration transforms the technology used in the installation from an unobtrusive mediator to an instrument for reflection. As Bolter and Gromala claim, "an interface can be not only a window but also a mirror, reflecting its user." (2003, 56) Using technology as a mirror provides a frame for more embodied relations through the incorporation of the body itself and its interaction with technology as both content and context of the artwork. Like standing between two parallel mirrors, the technology frames the body, the body frames the technology, reflecting endlessly, bringing both body and technology from the periphery into the centre and drawing attention to their relationality.

The work of Rafael Lozano-Hemmer provides a plethora of examples of how digital relationality reframes the body and technology. As art historian Kathryn Brown claims, "his installations… reshape individuals' encounters with the familiar spaces they inhabit, and alter the ways in which computer technologies are used within those spaces." (2014, 38) Lozano-Hemmer's work fits digital relationality by drawing attention to social relations and how they are shaped by technology. His artwork reimagines ways in which familiar, typically intrusive, technology, through its deliberate misuse, can be repurposed to facilitate relationality, revealing new possibilities for social connection while attuning participants to the lack thereof in their everyday use of the technology.

Brown points to *Amodal Suspension*, which reimagines text message communication using beams of searchlights to establish communication links. "The work takes up a technology that is potentially private and isolating and transforms it into a medium that is both public and communal." (Brown 2014, 52) Text messaging is transformed from a transparent communication medium to a tool for reflection. It invites reflection on how our technological habits shape us and our social relations.

By situating his relational architecture installations in public spaces Lozano-Hemmer also overcomes Bishop's criticisms of the lack of antagonism in gallery spaces. For example, *Border Tuner* connects people across the US/Mexico border through an interaction similar to *Amodal Suspension*. Not only does this affect those directly participating, but it produces a light sculpture visible to everyone in the surrounding community who may have diverse opinions on its significance and meaning. As stated on the project website, ""Border Tuner" is not only designed to create new connections between the communities on both sides of the border, but to make visible the relationships that are already in place." (Lozano-Hemmer 2019)

According to installation artist Nathaniel Stern, interactive artwork reframes the body's movement, thoughts, and sensations. Interactive art can form

the necessary structure needed for relational aesthetics. As Stern suggests:

> Interaction is a limitation—but it is also an amplification. At its limits, interactive art disrupts our relational embodiment, and thus attunes us to its potentials. Embodiment is per-formed in relation, and interactive art stages us, and our surroundings, so as to suspend, amplify and intervene that very performance. (2013, 13)

Stern frames new media technology as a cross-modal and embodied form that amplifies relations, rather than Bourriaud's assertion that it can compound discrete separateness. In this way, giving individuals an opportunity to observe the relationships produced and mediated by the artwork provides it with the substance that Bishop found lacking in Bourriaud's examples. Immersive installations can comment on the technology they are created from and propose ways to promote relationality. Here we present two examples of interactive artworks that explicitly invite embodiment, discourse, and intersubjectivity.

3.1 Gestures

Gestures is an interactive installation created by Lark Spartin that uses a Kinect to visualise human movement, resulting in a computational drawing machine. Human body movement is an art form in itself, acting here as an expressive digital brush to create an interactive painting projected in physical space.

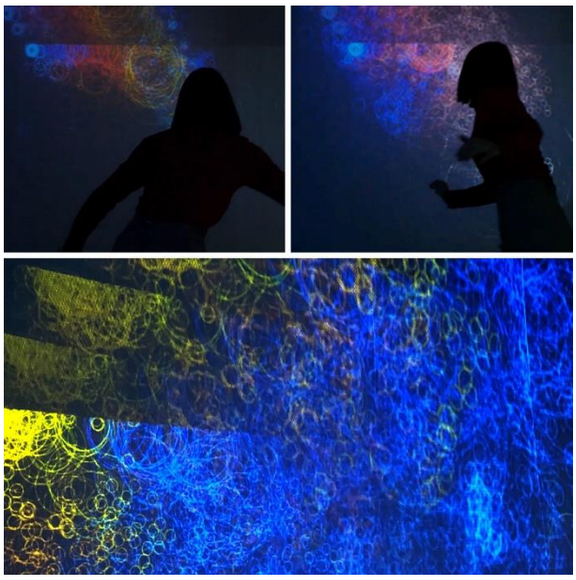

Figure 1: *Gestures. Top: participants observe changes in the colours and shapes corresponding to their movement. Bottom: projection onto multiple layers of tulle. Photos Lark Spartin 2021 CC BY-SA.*

During the exhibition, participants were encouraged through the intentionally open-ended interface to explore movement alone and with others, using their bodies as the context of the work as they actively created the content. The colours and shapes appearing on screen depended on participants' physical position in the installation space. By seeing how the content of artwork can change based on their proximity and speed of movement in real space, individuals could discover the relationality between one another, the technology, and the physical space between them. *Gestures* provided an opportunity for participants to move their bodies in ways that are seldom seen in everyday life. Without a barrier to shield these interactions from other spectators, some social discomfort was observed. This highlights the lack of privacy we ordinarily operate with as we curate our social expressions in our use of social media technology. Many participants were hyper-focused on how their bodies interacted with the technology at first but became more comfortable with moving within the constraints of the system as they became familiar with it, allowing them to collaborate with others.

Aligning with Stern's observations, *Gestures* can attune users to their bodies, while also embracing an underlying notion of performativity and limitation that is folded into the technology, as underscored in Bishop's call for antagonism. *Gestures* provided a form of utopic, embodied interaction that references Bourriaud's aims, while simultaneously embracing the inevitable antagonism that lies between the participants performing publicly. This artwork showed participants that the body can be reframed in relation to others by using technology to encourage expression and movement. *Gestures* dualistically furthers self-expression and relationality while making users aware of how technology mediates those social relationships by provoking discomfort to deconstruct the commodified social relations that are presently observed in our daily lives. It recognises spectators as active performers while reframing how we relate to our surroundings and how they relate back to us.

3.2 Body RemiXer

Body RemiXer, by John Desnoyers-Stewart et al. (2020) is a mixed reality immersive installation that can be used both with and without a VR headset, creating a space that encourages interaction across the virtual/actual divide. Participants' bodies are tracked by a Kinect (V2) and projected onto two perpendicular projections and within the VR headset. These projections act like mirrors that provide a link to the virtual space. One person wears the VR headset while up to 5 other participants around them are transformed into ethereal auras.

Body RemiXer hides individual identities and obscures others' gaze, encouraging expressiveness and interaction between both friends and strangers. By high-fiving, participants can connect their aura bodies through an exchange of particles, or swap their virtual bodies, drawing their attention to the connection or similarity between them. A soundtrack plays with each ambient track representing a participant, and each drumbeat responding to the synchronisation between connected participants.

Like in *Gestures*, *Body RemiXer* draws immersants' attention to their relationality by transforming movement into expressive visuals and sound. Both materialise the digital—*Gestures* through projecting the digital onto analogue materials, *Body RemiXer* by incorporating tactility into the ordinarily ethereal space of virtual reality (VR). *Body RemiXer* responds to assumptions about VR as an ethereal, remote, and solitary space by bringing real physical bodies into the virtual experience. Subsequently, the social effects of the virtualised body are seen through strangers interacting with, performing for, and touching each other. The hybrid space invites creativity and reflection on what our virtual reality *could* be.

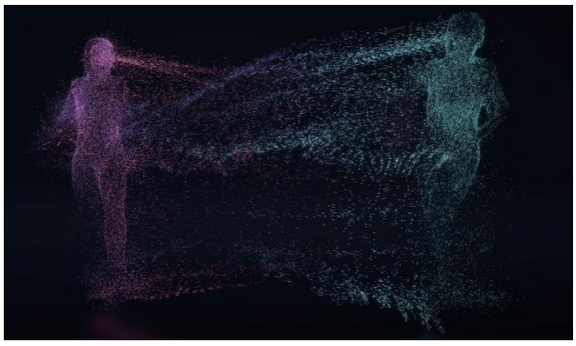

Figure 2: *Screen capture from Body RemiXer showing aura bodies being connected. Photo CC BY-SA.*

While it does propose a kind of "micro-utopia", Body RemiXer nonetheless embraces antagonism. In particular, touch between strangers presents an opportunity for sometimes abrasive experiences that draws attention to the strangeness of VR as well as everyday social norms surrounding touch. The creators of Body RemiXer observed that participants seemed to want to reach out and touch those around them in such an abstract and anonymous space (Desnoyers-Stewart et al, 2020). This antagonism was amplified by the fact that those in VR seemed to follow different social norms than those around them. Moreover, the uncanny sensation of touching a real, sometimes unknown person in VR invites participants to reflect on why VR ordinarily lacks this important sense while blurring the digital and physical. Such effects upon social norms draw attention to how technology shapes our bodies and our relationality with one another. Moments of discomfort are essential as they point to the tensions that exist within the technology and social structures, allowing participants to reflect, discuss, and hopefully transform them.

3.3. Moving, Thinking, Feeling through the Body as Framer

Interactive artworks such as Gestures and Body RemiXer give us insight into how our body can be formed (and reformed) within contemporary media, and provide the structure that Bishop found lacking in relational aesthetics. This structuring around body and technology helps individuals to contextualise the artwork for themselves, practising 'conceptual-material relationships'. By encouraging participants' shared meaning-making through interaction with the installation we can encourage relationships that are both individually and collectively significant. Through digitization, the image has become more closely tied to the body. As Hansen says,

> When the body acts to enframe digital information, what it frames is in effect itself: its own affectively experienced sensation of coming into contact with the digital. In this way, the act of enframing information can be said to "give body" to digital data—to transform something that is unframed, disembodied, and formless into concrete embodied information intrinsically imbued with (human) meaning. (2005, 12)

Viewing the 'body as framer' as Hansen suggests can provide a path to evaluating the quality of relationships produced within the work. Interactive installations call our attention to our "varied relationships with and as both structure and matter… framing the moving-thinking-feeling of how relations matter, as matter." (2013, 15) As Stern proposes here, in such interactive relational artworks, the viewers' bodies intersect with the artwork, providing both the framing structure, as well as the subject matter for the work. This respects Bourriaud's initial assertion of 'structure as subject matter' while resolving Bishop's criticisms by providing clearer parameters with which to define it.

4. DIGITAL RELATIONALITY IN SOCIAL MEDIA AND AUGMENTED REALITY ART

Parallels can be seen between these interactive installations and the way social media can be exploited to create relational art, as both of these realms can be used to bring awareness to how our seemingly mundane use of technology significantly shapes us. We can upend this by understanding through our use that subjectivity is no longer based on fictitious social 'harmonious community-as-

togetherness' as Bourriaud might like, but instead acknowledges the 'divided and incomplete subject of today.' (Bishop 2004, 79)

For example, Cindy Sherman posts uncanny digitally manipulated portraits on Instagram (2021) to point to the constructedness of the platform and Jenny Holzer delivers words and ideas in public spaces through her projection work, providing a call to question mediums themselves and a foundation for discourse in globalised, digital space (2019). By voicing that which is ordinarily repressed in social media, we become aware of the constructedness of the platforms and the performative identities individuals present. We make way for more conscious and affective social exchange by producing and critiquing culture in this new context. In this way, digital relationality can promote democracy, antagonism, and structure through art made within the platforms it critiques.

4.1. Amplifying Relationality through Augmented Reality

Many social media platforms including Facebook, Snapchat, and TikTok have integrated Augmented Reality (AR) through various filters that can be applied in real-time. While some are clearly visible as they radically transform the user's image, others such as Facetune are meant to be transparent, invisibly perfecting one's image. Regardless of their transparency, they quite literally filter how we relate to ourselves and one another and as such are an ideal topic for digital relationality.

In response to this, Lark Spartin created a digital portrait series named *In Flux.* The purpose of this project was to bring awareness to the constructedness of digital identity in contemporary culture. *In Flux* explores the evolution of self as mediated by technology, and calls attention to how individuals use digital technology to disperse the fractured roles they play in their lives and online. By exploiting the selfie, *In Flux* brings awareness to how different personas are performed on social media platforms. Lark Spartin uses her own image as the foundation of this project, manipulating her own selfies and found footage to create a collection of distorted self-portraits presented through an Instagram-like interface. Alongside the portraits, AR filters can be accessed through a QR code and interacted with anywhere, leaving the utopic constraints of the gallery behind. Users can upload their own images from their camera roll to the face filter or interact with an array of filters that purposely distort the user's face to bring awareness to the contrived, superficial nature of the selfie. Facial and gestural movements commonly seen in selfies, such as a smile, trigger animations within the selfie filter, bringing awareness to how we perform these interactions out of context in our perfunctory everyday use of AR. These design decisions give recognition to how the medium affects our perception of ourselves and others and allow individuals to infuse their own significance within the composition. To experience augmented relational work in this way is the epitome of experiencing a relationship "with and as both structure and matter", as Stern remarked (2013, 4).

Lark Spartin has also created a triptych of marker-based AR posters and video projection works: titled *Distant Distraction*, *Foul Breach*, and *Separate Sensation*. Each piece represents a body part (eyes, mouth, ears), referring to a perceived disembodiment that occurs in our digital interactions. In the AR layer, viewers can witness animated hands reaching out towards them as if reaching out for connection. Through presenting the AR filters within popular social media platforms, this artwork invites the viewer to reflect upon the problematic values that have arisen out of the use of social media and helps them consciously recognise what it means to "reach out" for authentic connection.

Figure 3: *Separate Sensation, Foul Breach, and Distant Distraction, by Lark Spartin. Photos CC BY-SA.*

These interactive AR images provide a similar structure that interactive installations afford through framing interactions while inspiring a level of collective antagonism by directly remarking on the social media platform used to view them. This project was meant to bring awareness to how our world is severely and socially separated by pervasive fear and the collective norms of social media, bringing in a collective form of antagonism to reflect on embodiment and relationality. When individuals flip to the front camera, a textured mask filter covers their face, promoting ideas of being a lonely, disembodied spectator. Superimposing a digital image into real space gives the digital image physicality and reminds the viewer of the real impacts such technologies have upon their lives. In the second iteration of this project, posters were switched out with scannable video projections that revealed the filters onto moving images.

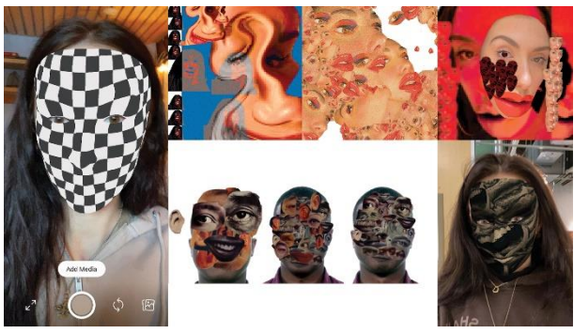

Figure 4: *Prototypes of digital self-portraits and AR face filters from In Flux by Lark Spartin. Photos CC BY-SA.*

These augmented relational artworks incorporate a participant/technology antagonism by encouraging individuals to interact with AR in a unique way, using it as a tool to promote creative expression or bring awareness to how they thoroughly impact how we envision our digital identity, promoting superficial connection and commodification. This is similar to Hook et al's idea of 'making strange', where we "shift from habitual movements so deeply ingrained in our habits that we cannot 'see' them anymore, into non-habitual, strange movements." (2019, 2) The AR filters are sharable through Instagram Stories and can be collected and archived via a hashtag. This creates a collective, evolving art piece that uses the social media platform as its exhibition space. By capitalising on AR's ability to visualise the intersections of physical and digital space, while still bringing awareness to its constructedness, we recognise these digital relations instead of allowing them to be transparently assimilated into everyday life.

5. DISCUSSION

As exemplified by these artworks, digital relationality inherits the aesthetic priorities of relational aesthetics transformed by the technical revelations offered by New Aesthetic images. Digital relationality takes social relations and their technological mediation as its subject matter. Digital relational artworks mediate human forms, behaviour, and interactions to reveal the effects of the mediating technology and related social structures to the viewer/participant.

We are often far too immersed within the platforms we use every day to recognise how they can bend our relationships out of shape. The examples discussed here make it clear how interactive art can exploit various media to acknowledge their powerful relational potentiality. Digital media has shaped the way that we collectively relate to ourselves, to others and our world. In our use of popular social media channels, the users are the product, and these platforms exploit our use daily. Such commodification of social relations has grown to levels unimaginable when Bourriaud first conceived of relational aesthetics. The business models of Facebook, TikTok, Google, etc. rely on directly commodifying our interpersonal relations. Through subverting these platforms, relational artworks can bring antagonism to a digital space that is in dire need of more critical understanding among its users. At the same time, social media platforms provide the antagonism needed in relational art. Bishop cites two artists, Santiago Sierra and Thomas Hirschorn, as emblematic of relational antagonism. Bishop states that their performances and installations are:

> marked by sensations of unease and discomfort rather than belonging, because the work acknowledges the impossibility of a "microtopia" and instead sustains a tension among viewers, participants, and context… (2004, 70)

Social media platforms, for many, are the opposite of a 'microtopia', as these platforms promote a certain level of social exclusion, and tension is surely heightened by the diverse users that interact with them. However, these tensions are often avoided through filter bubbles that safely segregate us by our interests and political views. Digital relationality offers an opportunity to return the antagonism and tensions critical to so-called democratic platforms for self-expression.

The way AR is used currently, mostly as filters integrated into social media to morph users' faces and beyond, amplifies these platforms' inherent superficiality and has significant effects on individuals' perceptions of themselves and others. Digital relational work aims to confront these entrenched problematic norms. This can take form through encouraging users to experience existing digital relational work or creating their own.

Through the deliberate and purposeful use of the platforms discussed and by resisting and deconstructing the rituals that contribute to conformity, we can move away from external social validation towards embodiment and authentic creation. Relational aesthetics was built on ideas that art should be integrated into everyday life. How digital relationality serves to benefit us is through using these platforms differently than how we do in everyday life. In this way, we can encourage individuals to evolve from individualistic consumers to relational co-creators. Users can begin to contest commodification, and question ownership and appropriation by using these platforms for their creative potential, by embracing forms of remixing, sharing and collaborative and individual artistic expression.

Extending beyond the origins of relational aesthetics, our participation in this global collective means we can also use these exchanges to create personal significance and shape our identity. The examples covered here give viewers a more active role in the production and interpretation of relational artwork. Users can reflect on the relationships they foster and make their own meaning through activated spectatorship and direct interaction, building upon the work while transposing these platforms. By finding these relational intersections, we can create a culture of use and contemplation that concurrently reflects upon and produces contemporary culture.

6. CONCLUSION

Embracing digital relationality can free individuals from viewing technology through a utilitarian, user-experience lens where comfort and transparency is prioritised over antagonism and relational reflexivity. Digitally relational artworks encourage discourse, discomfort and intersubjectivity, and it is up to users and creators to envisage them as such, outside of a strictly productive context, as the examples provided here distinctly demonstrate. Benford et al. argue for deliberate design and creation of uncomfortable interactions as part of cultural experience, to "underpin positive design values related to entertainment, enlightenment and sociality." (2012, 9) Realising that meaningful experiences, discourse, and personal growth do not occur in the absence of discomfort, or what Bishop refers to as antagonism, is essential to digital relationality.

The examples in this article directly question the technology and platforms being used in the artwork and *how* they are being used. If we can resist viewing interactions as commodity and art from a commercialist lens, we can deconstruct the disembodying effects our technology has and focus on the social structures it can promote. When we infuse relationality into technology by inverting its typical use, we encourage those who participate to become creators and performers. Through digital relationality, we can bring awareness to the role we all have in reshaping the technology we use and reflect on the technology that shapes us. By exploiting media in ways similar to the examples outlined, we become active participants in intentionally constructing a digitally relational future.

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Vignettes of Computer-based Museum Interactive and Games Software through the Years

Stefania Boiano
InvisibleStudio
London
UK
https://www.stefaniaboiano.net
stefania@invisiblestudio.it

Ann Borda
Department of Information Studies
University College London
London
UK
a.borda@ucl.ac.uk

Jonathan P. Bowen
London South Bank University
School of Engineering
London, UK
http://www.jpbowen.com
jonathan.bowen@lsbu.ac.uk

Giuliano Gaia
InvisibleStudio
Milan
Italy
https://www.invisiblestudio.net/founders
giuliano@invisiblestudio.it

Tula Giannini
Pratt Institute
School of Information
New York, USA
http://sites.google.com/view/tgiannini
giannini@pratt.edu

Museums have used computers to develop exhibition interactives and games over the years. This paper provides early case study examples and historical context. During the 1980s, computer-based displays in museum exhibitions were largely standalone. In the 1990s, the availability of the web allowed networked interactivity. In the 2000s, access via smartphones became increasingly widespread, enabling mobile access from personal devices. As well as the early examples, the paper provides an overview of more recent developments. Online gaming, including serious games with the purpose of not just entertainment, but educational and cultural, has increased in prevalence. Preservation and access to these digital resources have their own unique issues, and these are reflected in the paper, especially for early examples.

Computer interactives. Digital culture. Digital preservation. Museum exhibits. Online gaming. Serious games.

1. INTRODUCTION

This paper records some case study examples of museum-based computer interactives and games that have been developed over the years. Museums and digital culture have become increasingly intertwined through the decades (Giannini & Bowen 2019), with the Covid-19 pandemic accelerating the transformation even more since 2019 (Bowen et al. 2021; Giannini & Bowen 2021; 2022).

Heritage conservation and preservation has traditionally been concerned with analogue physical objects (Bowen 2017). However, it is increasingly the case that cultural resources are digital in nature. As well as digitised material, much is now "born-digital" in the digital revolution (Negroponte 1995; Palfrey & Gasser 2016), started by computing and information pioneers such as Alan Turing and Claude Shannon in the mid-20th century (Giannini & Bowen 2017). These digital resources now include material produced for exhibitions and outreach. There is a question as to how these digital resources can be preserved, while continuing allowing them to be accessed and appreciated. The techniques needed are very different from traditional preservation and conservation approaches (Deegan & Tanner 2006; van der Wal & Arts 2015).

In the following sections, we present some examples of museum-based digital resources from the 1980s onwards. These illustrate the changing technologies used and some of the issues in preserving and accessing them for the future. Section 2 presents

some early examples of museum exhibition interactives, including issues concerning their preservation due to changing technology and media. Section 3 presents an example of an online interaction 3D reconstruction in a heritage context. Section 4 discusses developments in online serious gaming more generally, from a cultural and educational perspective. We conclude with a poem on cyber games and some thoughts concerning the use and preservation of museum interactives for the future.

2. THE 1980S

Changing Technology

Within a lifetime, I (Jonathan Bowen) have seen digital media move from paper tape and punched cards in the 1970s through to magnetic tape, floppy disks (in three formats, 8, 5¼, and 3½ inches, from the 1970s onwards), various forms of hard disk, different types of magnetic cassette tapes and cartridges, CDs, DVDs, and more recently SD cards and USB sticks, all with increasing capacity and at dramatically decreasing prices per bit stored (see Figure 1).

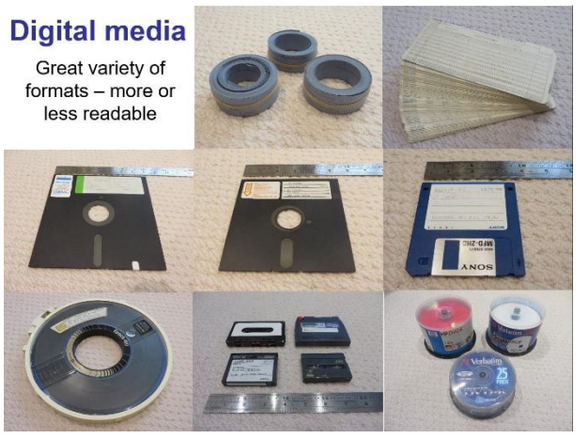

Figure 1: *Various digital media from the 1970s to the 1990s. (Photographs by Jonathan Bowen.)*

Different operating systems such as Unix (later Linux), Windows, Apple macOS, Android (for mobile devices), etc., add to the complication of formats. Text may be stored as ASCII text, Word, PDF, HTML, etc., with the possibility of embedded images in many formats. Individual images may be available in a variety of formats such as GIF, JPEG, PNG, TIFF, etc. Audio may be in AIFF, OGG, MP3, WAV, WMA, etc. Video may be in AVI, FLV, MOV, MP4, WMV, etc. All these different formats have various advantages and disadvantages in terms of quality, size, etc. Software is needed to view and convert formats, which may be easy or difficult depending on the formats involved.

Some older digital material may only be available in printed format (e.g., text, programs, and images on various types of paper and film). It may be desired to re-digitise such resources to animate them again. Sometimes printed versions of digital resources can allow easier access and longer-term preservation compared to a digital artefact (Diprose et al. 2018), although technologies such as fading thermal paper have their own issues (see Figure 2).

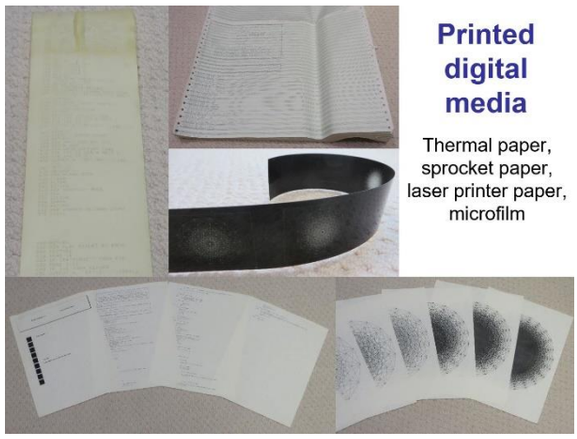

Figure 2: *Printed versions of digital media from the 1970s and 1980s. (Photographs by Jonathan Bowen.)*

Software works typically depend on a specific version of operating system or computer hardware configuration. Special custom-written software may form part of the material, particularly if it is dynamic and interactive. Software is typically very dependent on the environment in which it runs, and available facilities tend to change rapidly with digital developments in both software and hardware. This is applicable to early computer-based museum exhibits which could now themselves be of interest for preservation (Mayall 1980, p. 31; NMPFT 1983, p. 7).

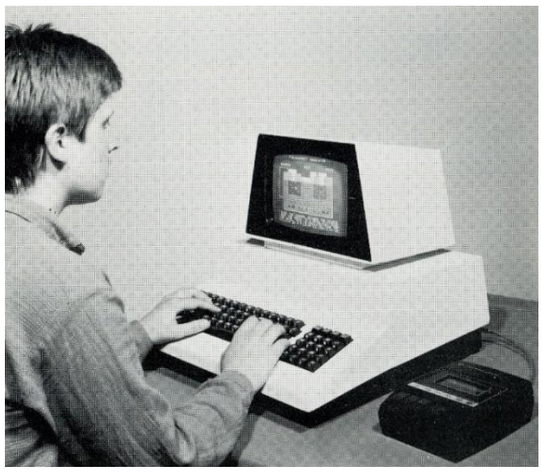

Figure 3: *Demonstration of a CMOS transistor on a PET personal computer for the Challenge of the Chip exhibition at the Science Museum, London, UK (Mayall 1980, p. 31).*

Museum Interactives

In 1980, I (Jonathan Bowen) produced an animated monochrome demonstration of a CMOS (Complementary Metal-Oxide-Semiconductor) transistor, written in the BASIC programming language on a Commodore PET personal computer for the *Challenge of the Chip* exhibition at the Science Museum in London, UK (see Figure 3). This exhibition covered developments due to the increasing power and miniaturisation of integrated circuits, especially for computing (Evans 1979; Augarten 1984). As well as museum exhibits, I also produced an early index system for the Science Museum on the PET computer (Bowen 1981).

In 1984, I produced a colour demonstration showing different focal lengths of lenses, using BBC BASIC on a BBC Micro personal computer for the National Museum of Photography, Film and Television in Bradford, UK (see Figure 4). The exhibit was located with a panoramic view of Bradford from the museum and a computer-generated version of the view, and the associated camera lens, using a lens with a focal length selected by the visitor.

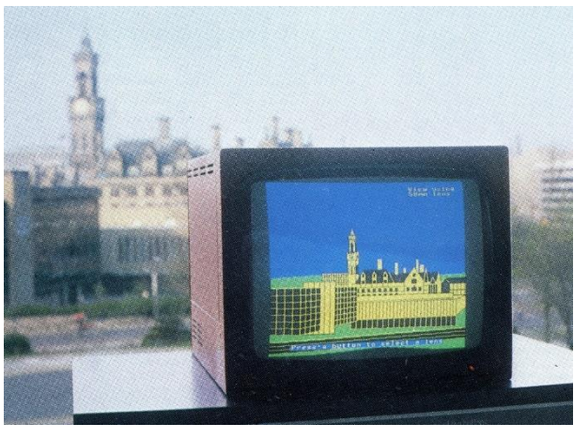

Figure 4: *Demonstration of different focal lengths of lenses on a BBC Micro personal computer at the National Museum of Photography, Film and Television, Bradford, UK (NMPFT 1983, p. 7).*

The exhibit was based on wireframe versions of the buildings in the view. In parallel, I worked on multidimensional hypercubes in BASIC on a Research Machines microcomputer (Bowen 1982) and the C programming language on a Silicon Graphics workstation (Bowen 1984). I also produced a BASIC geometrical plotting library of subroutines (Bowen 1983) and 3D wireframe software (Bowen 1984b; 1984c).

The change of storage media and formats, available software, hardware, etc., over the years, has made it difficult to conserve digital material in a useful way that can still be accessed and viewed by humans (Bowen 2017). For older digital material, the necessary hardware and software may be difficult to obtain or even no longer exist. What is more, the physical storage itself may deteriorate. Magnetism gradually disappears over a relatively short period. CDs and DVDs may become unplayable. Paper tape and punch cards last longer but can still have issues over a significant period if not stored well.

Since the 1980s and the time of microcomputers (Clark & Davis 2021), online resources have become increasingly important compared to hardware storage technologies. Earlier FTP (File Transfer Protocol) servers have been replaced by much more user-friendly web servers (very briefly via Gopher servers), with the “cloud” now available through facilities like Google Drive and Dropbox for widely accessible digital storage. Various web facilities allow the convenient storage of media online, such as Flickr for images, YouTube for video, and social media like Facebook allowing multimedia to be saved. The next section provides an example of a museum-based online interactive resource from the 1990s.

3. THE 1990S

The decade of the 1990s saw the rise of the web and increased use of computers by museums (Gill 1996). This enabled museums to achieve global outreach with online information and exhibitions (Bowen 1995; 1999; Gaia et al., 2020). Online gaming became practical, and museums were able to start exploring the possibilities from their own perspectives.

From Online Games to Virtual Museums

Online 3D games, as outlined in the previous pages, started to gain traction during the 1990s, along with the diffusion and strengthening of the Internet infrastructure together with the spreading of the World Wide Web.

The image of virtual 3D worlds was being shaped by cyberpunk novels, such as *Snow Crash* by Neil Stephenson (1992), where we can find the first definition of the Metaverse as an online 3D Virtual Reality environment shared by millions of users simultaneously.

At the same time, in 1999, the movie *The Matrix*, starring Keanu Reeves, gave visual identity to a digital online world where people conducted fictional lives. Even if VR (Virtual Reality) technology was (and still is) far from getting that degree of realism, the notion of online multi-user worlds was becoming more and more widespread.

When we (Giuliano Gaia and Stefania Boiano) were working at the National Museum of Science and Technology (Milan, Italy) in 1999, we were

dreaming about the possibility of recreating an online copy of the museum where visitors could meet and interact. When we discovered that Prof. Paolo Paolini of the Milan Polytechnic was working on a technology capable of doing exactly that, the WebTalk technology, we quickly made contact and offered the museum as a testing environment for the technology.

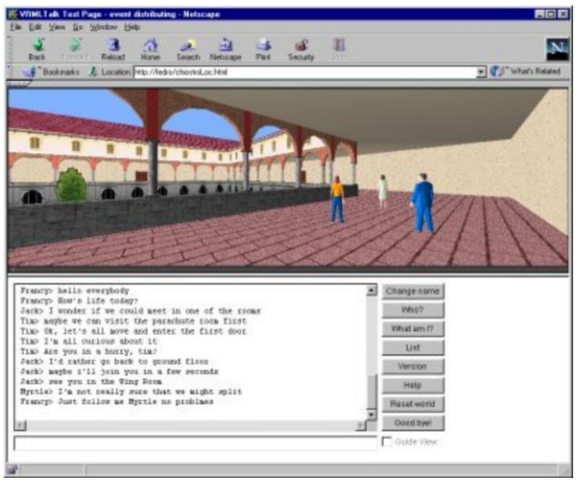

Figure 5: *Screenshot from Virtual Leonardo. Users can see each other and chat using the chat window in the bottom part of the screen.*

The result was *Virtual Leonardo* (Barbieri & Paolini 2001a), an online 3D reconstruction of the two cloisters of the Science Museum (see Figure 5), with animated Leonardo da Vinci's machines scattered around the virtual space (see Figure 6). Visitors could have their avatars walk and fly around the cloisters and rooms, chat with a guide or with other visitors, and set in motion the machines. The tour guide avatar had the special power to force all users to see what she was seeing in that moment, in order to make guided tours easier (Paolini et al. 2000).

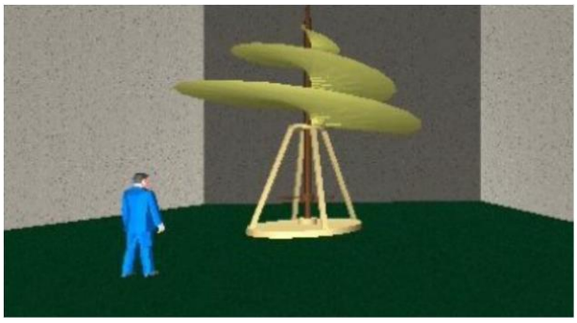

Figure 6: *One of the da Vinci machines, operable by online visitors.*

The system went online on 7 June 1999 and raised much interest, winning an Honorable Mention at the *Museums and the Web* "Best of the Web" awards in 2000 and being featured in the *New York Times*.

From a technological point of view, *Virtual Leonardo* consisted of a combination of VRML (Virtual Reality Modeling Language) technology, a markup language proposed in 1994 to create a standard for 3D visualisation in the World Wide Web (Raggett 1994) for the 3D environments and Java for the infrastructure allowing users to chat between themselves and to interact with the guide and the animated objects.

A problem was that the technology was still immature and not user-friendly. The user had to download and install a specific plug-in, Cosmo Player, to be able to visualise VRML and needed a good computer with a strong Internet connection to make the system work smoothly, something that was not common at the time. The result was that only 20% of the users were able to have a successful experience interacting with the system (Paolini et al. 2000); an interesting insight was that the average connection time among successful users was nearly one hour, confirming that the experience was "sticky".

The system was live for a couple of years, and a second version using Java 3D was developed in 2000 by the Polytechnic University of Milan. Together with the launch of the new technology, we decided to create a new virtual environment, related not to the existing museum but to the ideal city imagined by Leonardo da Vinci during his Milanese years (Barbieri & Paolini 2001b). See Figures 7 and 8 for two example screenshots.

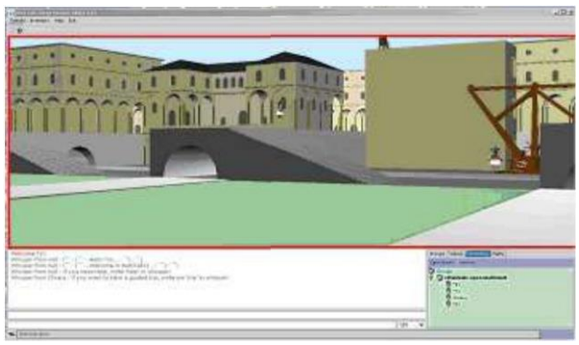

Figure 7: *Screenshot of the ideal city project. Beneath the 3D navigation area, the chat window (bottom left) and the collaboration area (bottom right) allow users to communicate with each other and with the virtual guides.*

In this case, the system was more reliable and easier to install and launch, provided the user had a good Internet connection and a computer powerful enough to execute some 3D graphics rendering. The virtual environment included not only da Vinci's machines but also artificial avatars operating them, in order to make the place more populated and to show first-time visitors what they could do in the environment.

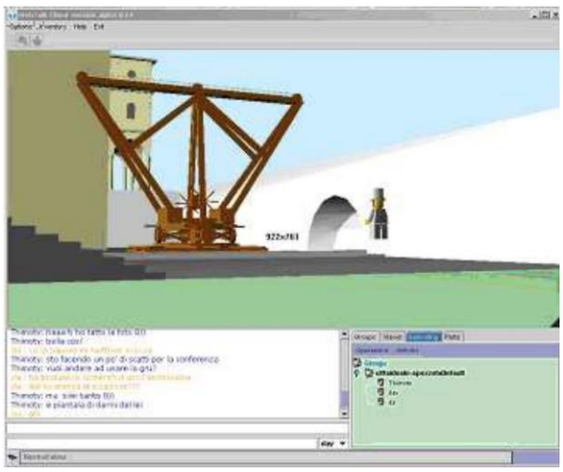

Figure 8: *A screenshot from the ideal city project. A user is approaching an interactive machine and operating it. All other users are aware of his movements and his actions over this particular object.*

Even if the Science Museum lacked the resources and the will to develop the project beyond the prototype phase, both projects demonstrated that a cooperative virtual environment, where users can interact with each other and interact with exhibits, has a strong educational value and is, therefore, useful to pursue. Whether this has to be done by building your own virtual environment, as we did, or by using an already existing environment, as some museums are doing with Minecraft (Charr 2021), is still open for debate; both solutions have pros and cons. However, in the end, we believe that museums will be an important contributor to developments in the new metaverse.

4. THE 2000S

In the 21st century, mobile devices have become increasingly important for the digital interactive provision made available by museums (Filippini-Fantoni & Bowen 2008) and for cultural heritage in general (Boiano et al. 2012). The rise of serious gaming in the cultural sector has a significant history associated with mobile and desktop devices largely developed for widespread use during the 2000s.

Online Serious Games

The term “serious games” can be credited to Clark C. Abt (1987), originally in 1970, who referred to (video) games created for purposes other than entertainment, especially for learning and education, training, skill transfer, or persuasion. Serious games have since become pervasive in military, education, healthcare, engineering, and cultural sectors, among others. (Borda & Bowen 2019).

Precursors to serious games in digital heritage reveal an integral relationship to early computing and video game technologies (Djaouti et al. 2011; Mortara et al. 2014). The *Sumerian Game* of 1964, for example, was largely a text-based strategy video game designed by elementary school teacher Mabel Addis (credited as the first woman game designer) and programmed by William McKay for the IBM 7090 time-shared mainframe computer using a teleprinter to input commands (Willaert 2019). The game, set around 3500 BC, has players act as three successive rulers of the city of Lagash in Sumer over three segments of increasingly complex economic simulations.

A long-running precursor to serious games, *The Oregon Trail* also started as a text-only computer game programmed in BASIC and designed by three history teachers. Released by the Minnesota Educational Computing Consortium (MECC) in the 1970s, the game casts the player as an American settler in 1848, whose goal is to travel by wagon train from Missouri to Oregon facing various challenges en route based on historical facts (Djaouti et al. 2011). The game was re-released several times with a graphical version of the game in an open-source format, followed by versions for Apple, Atari, Commodore, and Radio Shack computers. In 2010, mobile phone versions of the game were released on Windows, Android, iOS, as well as Facebook.

Although these early computer games were influential in shaping subsequent developments of serious games, it was not until the 2000s that serious games became truly popularised, culminating in internet, mobile-based, and VR (Virtual Reality) examples, in line with increasingly accessible and affordable technology platforms. Developments such as the Serious Games Initiative (Wilson Center n.d.), founded in 2002 at the Wilson Center in Washington, D.C. (Djaouti et al. 2011) and the growth of academic studies on serious games within digital culture reinforce their educational role.

Serious games have been variously categorised in relation to their increasing presence in digital heritage. Anderson et al. (2010) proposed a taxonomy of prototypes, demonstrators, virtual museums, and commercial historical games. Mortara et al. (2014) categorised serious games as supporting cultural awareness, historical reconstruction, and heritage awareness. Paliokas & Syliaou (2016) proposed a framework to describe the features of serious games in digital heritage, including elements such as technologies, categories of users, user experience, and game content. Rowe et al. (2017) focus on serious game design in science museums, highlighting the importance of free-choice learning environments. Wang & Nunes (2019) considered educational goals and genres.

The use of emerging VR has become a prominent characteristic, often focusing on the preservation of historical structures and artefacts reminiscent of

past cultures. Such preservation has been mainly "*through digital capture or detailed reconstructions, both having digital accessibility as an outcome*" (Ch'ng et al. 2018).

For example, *The Virtual Egyptian Temple* (launched in 2004–5) presented a realistic 3D model of an ancient temple to understand ancient Egyptian life and culture (Jacobsen & Holden 2007). Two versions were implemented: a VRML lightweight application and an *Unreal Engine* (Epic Games n.d.), supporting a higher level of visual detail and multiplayer capability networked over the internet, where each player drives a humanoid avatar.

Similarly, *The Forbidden City: Beyond Space and Time* (IBM 2008) was an educational VR game where players can interact as avatars and explore the Forbidden City in Beijing, China as it was during the Qing dynasty (1644–1912, see Figure 9). This initiative was a partnership between the Palace Museum and IBM, utilising a 'Second Life'-like world and built using a Torque game engine.

Figure 9: *Avatar in the Hall of Mental Cultivation in the virtual Forbidden City. Image by Mary Harrsch, 2009. Flickr CC BY-NC-SA 2.0. https://tinyurl.com/2p8vbpcu*

European Union funding contributed further to the development of several advanced virtual heritage demonstrators using serious games and digital storytelling. One example is *ThIATRO* (The Immersive Art Training Online) – a prototype of the Virtual 3D Social Experience Museum exploring the bidirectional interaction between museums and visitors on a Web3D basis (Froschauer et al. 2013). ThIATRO was built in the Unity Game Engine and 3D models designed with Google SketchUp (https://www.sketchup.com). ThIATRO aimed to immerse the player in the role of a museum curator in a virtual 3D exhibition to find artworks to create their own exhibition. It was primarily intended to be played online in a web browser.

At the time of THIATRO's development, data for the game was drawn from newly available online resources such as the Web Gallery of Art (https://www.wga.hu/). In the context of art history, there were already major projects exploring virtual heritage environments like the *Google Art Project* launched in 2011 (now Google Arts and Culture) where users can take virtual tours through selected museums via web-based browsers.

Early mobile serious games like *Art Tournament* (Froschauer et al. 2012) ran on mobile device platforms, which were becoming more ubiquitous post-2010, but offered less computing power for immersive capability in older mobile devices.

Rather mobile geo-locative games were readily being adopted for outdoor exhibitions and self-guided tours and games, such as *M-Heritage Hunt* (Tan et al. 2011), an app to explore the cultural history of George Town in Penang, Malaysia, and *Eye Shakespeare* (Creative CH 2013), an Apple app developed by Hewlett Packard for the Shakespeare Birthplace Trust. The American Museum of Natural History launched an innovative mobile gaming app *MicroRangers* in 2015, as a way for the public to experience the museum's collections in situ, 'shrinking' the user down to microscopic size to combat threats to biodiversity. The app utilised AR (Augmented Reality) technology, like that seen in popular gaming apps such as Pokémon Go.

Currently, more highly immersive serious games are crossovers with VR experience interactives, and usually the result of a commercial partnership between a heritage organisation and VR design companies. A drawback is the need for VR headsets and/or gaming computers in some instances. The serious game *Chauvet: The Dawn of Art* (Tanant 2020) is a project of Google Arts & Culture, supporting mobile-based AR and VR interactive narratives and using photogrammetry and physical-based rendering. The Chauvet Cave is a UNESCO World Heritage Site located in the Ardèche gorges in southern France, with cave paintings dating from 36,000 years ago that are inaccessible to the public.

Ace Academy: Black Flight is one of several serious games developed from the collections of the Canada Aviation and Space Museum (2017). The mobile game is available on Apple Store and Google Play, and players can climb into a cockpit to fly with real First World War squadrons, over actual historical locations and engage in aerial combat. The game won a gold medal in the 2017 International Serious Game Play Awards.

Personalisation of the learning narrative in a game is a consideration of the Getty Museum's recent collaboration with Nintendo's *Animal Crossing*, allowing users to import art masterpieces into their digital homes using the International Image Interoperability Framework (IIIF, https://iiif.io) in an online game activity called *Art Generator* (Getty n.d.). The Generator is also linked to a uniquely generated QR code that holds information on the

artworks. The Covid-19 pandemic has focused attention on digital heritage, engaging in one's own personal spaces, at a time of social distancing and limited access to physical buildings. It is not surprising that many cultural heritage organisations increased their digital footprint, publishing stories, games, and quizzes, among other resources (UNESCO 2020). However, as the UNESCO report points out, there remain access issues for lower economic regions and countries, as well as a gender divide in access and use of the Internet.

To date, participatory forms of digital culture have not relied heavily on serious games as these largely tend to be single-player games, although multiplayer role-playing game technologies are steadily gaining interest in heritage organisations (Charr 2021). Different types of citizen science approaches have the potential to support more inclusive participatory directions in which the participant has a greater role in solving problems or actively contributing to content (Borda & Bowen 2019). For instance, the gaming experience can serve the analysis of complex data by leveraging the ability of the gamer to perform pattern recognition tasks, such as annotation and identification projects on the Zooniverse platform (https://www.zooniverse.org/).

Thousands of participants joined *Project Discovery* (EVE Online n.d.), an initiative of the Human Protein Atlas (HPA) that aims to map protein expression in the human body. Project Discovery enticed gamers to help analyse a quarter-million images of stained tissue samples by embedding the scientific data within EVE Online, a futuristic role-playing game with nearly a million subscribers (Peplow 2016). This type of participation points to the capability of machine learning and artificial intelligence (AI) alongside human intelligence – and by extension, the possibility of AI-enabled serious game applications, for instance (Gaia et al. 2019).

Serious games have further potential to become co-created by participants (Boiano et al. 2019). The *Raices* game, for example, involves artists, computer scientists, anthropologists, and primary school teachers to co-produce a game to help school children better understand the historical and current issues of native Argentinian peoples (Diaz et al. 2014). The Wilson Center has recently curated an overview of digital games that bring black history and contemporary experience to life, most of the examples produced by those with a lived experience (Newbury et al. 2021).

These examples perhaps highlight the intertwined relationship of serious games, not only to educational goals and technology appropriateness but increasingly to the ways in which participation and learning need to be considered as both an individualised and community-based experience.

5. REFLECTION

Cyber Games (by Tula Giannini)

Is life the game
in a digital frame
Going to cyberspace
Choose your avatar face
No place for reality
where love's a fatality

Come join the game
Leave life behind
Don't look back
Stay on track
Revel in your new identity
Future serenity
No place for reality
where love's a fatality

Haven't played games
since Hopscotch and Double Dutch
Missing you so much
Take me back to reality
Oh – a Covid fatality

6. CONCLUSION

This paper records some case studies of museum-based computer interactives and games over the decades. The changing technology over this time means that these can rapidly become difficult to animate, even if the software is available on some media.

It is possible to write emulation or simulation software that mimics a computer system, but even this can have issues (Bowen 2017). Often it can run faster than the original system and dynamic material may depend on the speed of the emulator/simulator as well as its functionality for satisfactory operation. Simulation can be achieved typically through the use of software. Emulation provides much more precise behaviour and can be undertaken using programmable hardware for example, such as Field Programmable Gate Arrays (FPGAs).

The redisplay of early digital artefacts can involve any of the issues described above, depending on the complexity. While a traditional painting can be physically conserved and then hung for display, the same process for a digital work is potentially much more complex, even after a period of only a few years from its origination. This will be an increasing added complexity for museums in the future wishing to preserve their digital artefacts and resources in a meaningful way. Meanwhile, the boundary between real life and digital will become more and more blurred as time progresses (Borda & Bowen 2019; Bowen & Giannini 2014; 2019; 2021).

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From Pixels to Drones: Visualising The Nation in the London 2012 and PyeongChang 2018 Olympic opening ceremonies

Richard Whitby
University of Greenwich
10 Stockwell St, London SE10 9BD, UK
r.whitby@greenwich.ac.uk

1. INTRODUCTION

Thomas Hobbes's *Leviathan* (1969) famously features a title page picturing a figure made up of smaller figures, vividly and memorably visualising the relationship between a state and its citizenry. Two recent Olympic opening ceremonies can be seen as also attempting this, by differing means: visualising the UK in 2012 and South Korea in 2018. I will bring together observations on the weird technical elements so heavily present within this micro-genre of large-scale performance, alongside a consideration of the offering to both global and local audiences from two image-conscious nations.

2. VISUALISING THE NATION

Any Olympic ceremony is a broadcast event that attempts to produce and mediate an image of the host country. As early as 1936, Leni Riefenstahl constructed a hybrid image of Germany in her film Olympia (1936), which encompassed a filmed narrative introduction to the games Berlin games, the opening ceremony and the sporting events themselves, intended to be shown in cinemas around the world. Arena events such as these fuse different kinds of presence. There are the athletes, celebrities, politicians and heads of state; there is the audience in the building and a remote audience via broadcast media and the internet; the stadium floor being a space of image production. Together these constitute an image of a country for consumption both at home and internationally, that can tell us interesting things about that country.

2.1 London's pixels

Danny Boyle's production for London 2012's summer games mixed amateur performances, celebrity appearances, large scale and complex sets, and an approach to broadcast that he likened to making a 'live film' (Gibson 2012). What might seem like a participative and inclusive work was actually more like an automated panorama made for the 'eye' of the world's media – and this viewpoint was also visible to the performers themselves on the arena floor, via large screens all around the top of the building.

A device that was first used in London (and also used in PyeongChang) are small sets of lights called 'pixels' attached the spectators' seats in the arena. These effectively turn the arena stands into a low-definition screen, further emphasising the spectators' role as part of the image. In this visualisation of the UK Spectators are fused together within the broadcast images as part of a video screen that displays and watches simultaneously. In Boyle's production, the arena was intended as a model of the UK, its culture and history, with nostalgia at its centre.

2.2 PyeongChang's drones

The opening ceremony of the PyeongChang Winter Olympics in 2018 was another huge and diverse spectacle, including puppets, musical performance, projected video and a record-breaking drone display (Chang 2019). Thousands of light-carrying drones created images including the figure of a snowboarder and, although this was actually performed before the night of the ceremony, was part of the performance as an edited video (a device widely used in contemporary ceremonies).

Whilst Boyle's ceremony dwelt on the past (both technologically and culturally), the PyeongChang ceremony frequently highlighted current and future technological innovation, reinforcing South Korea's established image as a place of hi-tech and rapid progress.

2.3 The arena floor as studio

These ceremonies are both marked by their peculiar ways of illustrating the host nation 'coming together' for the games. In 2012, the UK was two years into a programme of austerity, seemingly belied by the extravagance of the games and associated regeneration in East London. Boyle's 'green and pleasant land' rolled out over reclaimed London 'wasteland' and the Queen apparently parachuted in with James Bond.

In 2018 the two Korean states – still technically at war – walked under a single flag and apparently celebrated the possibility of reconciliation. In Boyle's ceremony we watched the arena audience watching the show; in PyeongChang we watched President Moon Jae-in, Mike Pence and Kim Yo-jong (sister of dictator Kim Jong-un) awkwardly watching the ceremony together.

In these largely post-industrial countries relying on soft power, the image is the product. The live and recorded blended and the arena floors were productive sites of image making; bodies on the stages, seats and screens used to manufacture specific images of the host nation.

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A-MAZE Artists Update 2022: On the development of the *Boundless – Worlds in Flux* virtual world

Fion Gunn
31 Stanthorpe Road
London SW16 2DZ, UK
fiongunn@live.co.uk

Maureen Kendal
13 Golders Green Crescent,
London, NW11 8LA, UK
maureen@dreamstudio.io

Barney Kass
29 Elkstone Road, London,
W105NT, UK
barneykass@outlook.com

Alan Hudson
3 Priory Place, Wells, Somerset,
BA5 1SP; 117a Iverson Road,
London, NW6 2RA, UK
alan@alanhudson.org

Mei-Tsen Chen
26 rue des Plantes
75014 Paris,
France
meitsen668@gmail.com

Building on previous development, the A-Maze artists continue to develop 'Boundless – Worlds in Flux – a Virtual Reality platform with a hub leading to different Artists' spaces. During 2021, the team has reached out to museums, site-specific communities, user groups and expanded the team to include new design developers. This paper will chart this development, new insights, challenges and next steps. Insights include the response to global crises and transitional change; conversations with cultural theorists, other Artists and Artists' collectives, curators and audiences; new perspectives on the Museum experience and decolonisation of collections, site-specific artworks and the embedding of cultural life within the community; aesthetic considerations; technical problem-solving and team-working.

Digital collectibles. Immersive realities. Artist collectives. Ecology. Virtual reality.

1. INTRODUCTION

A-Maze Artists' Collective is woman-led and includes practitioners of all ages & diverse cultural backgrounds with a range of artistic and technical skills. This collaboration grew out of a particular historical moment, the Covid-19 pandemic. The crisis showed us how interconnected we all are and how, if we can just change one thing in our lives, it has an impact on everything else. Gunn initiated this group in March 2020.

Our areas of enquiry include: people's experience of displacement, migration, realisation of virtual worlds through emerging digital tools and reaching out to audience-participants. We collaborate using online regular weekly meetings to design and build our virtual artists' world: 'Boundless – Worlds in Flux'. Here audience-participant-users-visitors are able to share the artists' passion for the planet and its inhabitants (A-Maze artists collective 2021)

This virtual world enables visitors to navigate their way through interconnected artists' worlds where visitors access a range of experiences. Hotspots for interactivity can be accessed in any order, providing visitors with an open-ended experience, one which can be revisited to bring new insights. The experience is similar to visitors dropping into a museum or public gallery, allowing them to focus on different collections or exhibitions depending on what appeals and how much time they can spend there.

In addition to the Artists' spaces, visitors access the participants' space called 'Your Space' where they can join the creative conversation and leave their own comments, video clips, photos, music/sound clips, poetry etc. This is a generative space growing in size and complexity over time (Gunn 2021). Users can create their own assemblage, becoming user-creators.

2. BACKGROUND

'Boundless – Worlds in Flux' is built on research into development of virtual world platforms, enabling poetic envisaging and innovative responses to real world curatorial issues such as concerns around the use of VR and audience engagement.

2.1 Prior research

2.1.1 Research on Second Life virtual avatar worlds (2007–2011)
This immersive avatar-populated environment was built on cultural traditions of the miniature, the doll's house (Stewart, S. 1993) and a craft culture, to encourage learning, reflection and writing. Insights included observations of 'parallel play' and development of interiority of an internal voice and reflection (Hudson and Kendal 2011).

2.1.2 Virtual world workshop for 'PinghubVR' (2018–2019)
The workshop offered the artists the opportunity to work with a range of online design tools including TiltBrush, digital audio. Artists shared a common online space and forum between artists in London and Malaysia. Kendal, Mulla and Thomas-Freitas, 2019, investigated how artists could create innovative immersive and virtual art and build upon their tangible skills, during this workshop with its digital pipeline and tools. The workshop facilitated traditional and new media artists to create immersive 360-degree 3D worlds. Observations of the artist and their working practices were seen as performative. In this context, picture the artists in their headsets moving balletically as they design their art space. In essence, as performers demonstrating their pervading sense of interiority. Thus, adding to the traditions of art as performance and drawing as performance. Research indicates that Art as performance allows: 1) the freeing of art from confined interior spaces, 2) art as performance that is subjected to the influences of the unexpected and unscripted (Foa, Grisewood, Hosea and McCall 2020). Here this observation depicts a third aspect 3. Here, the Artist as performer, is invisible to themselves, immersed within, as it were, a womb of creative imagination. Within this playground, Elwes, 2015, describes the artist's desire to be recognised, found and integrated but also in the same moment, acting on a compulsion to be an isolate, to hide, assuming disguise as if in a game of hide and seek. The immersive VR playground affords this desire to show and a compulsion to hide.

2.1.3 Exploring how artists use immersive technologies to promote inclusivity (2020)
Insights included activity by 'inclusive' artists, "osmotic seepage between virtual and physical realities" and the need to address interoperability, standards and platforms across emerging technologies, (Gunn, Kendal, & Mulla 2020) These reviews encouraged Gunn to develop an artists' collective – A-Maze Artists.

2.1.4 The evolving collaboration (2021)
AMazed!, was the next stage of the initial pilot for the artists' collective. 'The A-Maze artists investigate Immersive Technology to create Imagination and Artifice, 2021' explored transitional spaces and transportation tunnels were designed to integrate the different Artists spaces within one Unity gaming platform.

2.1.5 Integration and development (2022)
In 2021, the 'Boundless – Worlds in Flux' new designer-developers joined Grant to action the Unity integration stage: Barney Kass – a designer of systems as a compositional tool to interweave narrative, interaction and information into installations, sound design and music (Kass 2022) and Alan Hudson – virtual world specialist (Hudson, 2022).

A-Maze artists continue to deepen conversations with other artists and artist collectives, museums, galleries and specialists in Liverpool, Paris, Athens, Taiwan, Poole and USA. The integrated virtual world enables playful experimental sandboxes and 'juice up' the gameplay.

2.2 Perspectives: The museum curator

When considering the traditional museum curatorial gaze, it is worth analysing a frequent dilemma faced by these institutions. In their curatorship of collections, responsible for conservation and preservation of historical objects, they often find themselves unable to include contemporary creative voices because of the physical challenges they present. Artists by their nature are frequently disruptors, dynamic, unpredictable and inventive in their planning, they do not necessarily share the priority of archival standards of conservation and may come from very different cultural traditions and have different cultural and aesthetic values. Decolonisation of collections is not just a matter of objects and ownership, it is also about decolonisation of a mindset mired in values of Empire, hierarchy, and belief of being under siege.

Thus, the rise of a virtual, immersive artist practice which obviates the physical endangerment of precious objects should lead to a more expansive, visionary and inclusive curatorship of collections. It should – once cultural institutions get their heads around the technical barriers and their fear of the unknown, by up-skilling existing staff and collaborating with artists who can use these media. This will enable the sector to become more resilient and inclusive going forward, in particular, it may inspire greater generosity between museums locally, nationally and globally in terms of how they

share their collections. Blended media projects will also enable an expanded view of what curation can mean by providing both an online and a tangible experience. Crucially for artists, for local groups and the wider community, they may find greater opportunities to collaborate and co-create with institutions. In short, the multiple perspectives gained from working in this way will make the museum/public gallery sector truly fit for purpose, (Gunn 2022).

Trickett in 2022 proposed to Gunn and Kendal that: "if and whether Virtual Reality can be defined as an immersive, interactive, computer-generated world, where headsets are not a necessity?". It was mutually acknowledged that curators can be hesitant about the use of headsets by exhibition visitors due to extra staff required for setting them up, monitoring and assisting the public, health and safety issues around hygiene and bottlenecks of queuing visitors to use a limited number of headsets. From the outset the A-Maze artists are designing 'Boundless – Worlds in Flux' for several levels of audience and intergenerational access. Visitor access includes smartphones, laptops and tablets, headsets, gallery projections with dynamic installations and sensory trigger points. An augmented reality level affords signage to stimulate visitor flow in under populated or poorly utilised areas of museums and galleries. An experimental version using WebGL is in process, (Hudson,2022).

However, to be clear, the Unity specialist Linowes (2020) indicates that VR is considered to be the use of headsets and is different from 360 degree immersive-like art installation which often includes user triggered sensory features. The advantage of VR uninterrupted view of the 360-degree experience enhances the capability of field of view. Future capabilities will capture stereo 360 degrees viewing e.g., Light Fields. Given that the practicalities and appeal for a museum audience-user is crucial, the design needs to be adaptable for multi-platform future development, access and engagement to include VR, but not exclusively.

2.3 Technologies, tools and platforms

Unity platform set up for VR can enable access to different delivery platforms. Export functions include Android, iPhone, gaming consoles, and Web, as an Exe from iOS and Windows and on Oculus Quest or Oculus Go. The alternative Game Engine is Unreal. Some developers recommend Unreal if the project requires focus on high-end graphics and gameplay. Unity remains the industry standard and the royalties remain with the developer (Arora, S. K, 2021). Kass, 2022 noted that given the artists' original starting point was the Tilt-Brush workshop, Unity is technically most similar to Tilt Brush and not compatible with Unreal and Blender for this current stage of development.

3. METHOD AND WORKING PRACTICES

The artists' working practices consider aesthetics, technical specifications, user testing. The pipeline process started with experiments with tools e.g., Tilt-Brush, Unity. Integration stage indicated inconsistencies and incompatibilities.

3.1 Aesthetic considerations

These include site-specific environments; collage/montage/assemblage; conversations and communities.

3.2 Site-specific environments

The artists were not documenting the real site-specific environment rather creating re-imaginings of futuristic, narrative or psychological virtual simulations. Chen's environment evokes the feeling of wandering, of strangeness. Designed using Unity to create video projection scenography, this world invites viewers to immerse in the movements of Jellyfish and to be lost in that sense of gravity and orientation. Entering with a first-person viewpoint, as seen by diver's bubbles, viewers explore and test out where the exit – liquid portals, might be located. Inside these interactive spaces, viewers will find pop-up windows as 'Iconography' and 'Ecosystem' where artists' images inspired by Jellyfish throughout the history of art can be viewed along with scientific research in the marine ecosystem. Chen raises awareness of the ecological crisis and shows how we are intimately connected with our environment. Jellyfish are certainly proving to be the only species capable of proliferating in the whole ocean by taking advantage of human misdeeds both technological and speculative. It is urgent to study the mutual relationships between living creatures and their biological, social, and environmental surroundings. Meditating on these facts and learning about the stories of Jellyfish in a trans-disciplinary way is key to the artist's vision.

Gunn created 'Odyssey: Ride' a virtual roller coaster springing from an imagined landscape. It circumnavigates an island planet floating an inland sea which teems with blooms of jellyfish and shoals of fish. Visitors can freewheel through vertiginous coils to hear stories told by a salmon, read poems hidden in rocks and see artworks lurking in caves. Metaphorical and mythical references underpin the structure of this world created in TiltBrush. This was Gunn's response to the state of uncertainty so many of us have experienced in our COVID times Her environment resonates with a soundtrack by composer Gráinne Mulvey, rhythmic waves of clapping, the result is a visual and aural odyssey with surprising directions and changes of pace. The

rhythmic soundtrack echoes the tidal movement in Kendal's environment as well as the Participants' Space and throughout the other artists' environments. Gunn's practice which centres around the movement of peoples, the micro and macro narratives of history and future envisaging is the inspiration for this particular 'Odyssey'. It is a response to a life where all plans have been changed, it embraces the unknown and is transported, excited by its potential. Field, 2021 in her debate on 'Scenographic Design Drawing', relates Gehry's scenographic design to Deleuze's idea of the 'fold', to indicate that: The (drawing) line embarks on a metaphysical journey, "entering into a labyrinth dividing endlessly … concave intervals of the whirls that touch one another", For Kendal, 2022, this evokes the imagery and the experience of Gunn's 'Odyssey' as metaphysical scenographic experience.

Kendal offers an 'imagining' based on her engagement with a specific Dorset shoreline and its hidden coves between Shell Bay and Swanage and the Jurassic coastal walks. A futuristic vision which imagines radical environmental shifts caused by rising seas and ecological interventions such as the introduction of beavers and wildlife sanctuaries. The shoreline as a liminal space and a national border, has, at times, welcomed and at other times prohibited fleeing migrants. Early childhood displacement and living at the edge of multicultural experiences is her personal journey.

Parvez has created an environment which evokes the feeling of displacement combining urban and rural, the built environment and agricultural one. Her city panorama is New York and can also be changed to London or other big cities. Parvez was inspired by artist Agnes Denes who grew an actual wheat field in Manhattan in the 1980's. Parvez who constantly explores the idea of displacement has incorporated connections to the real world in her environment. This is the first step in creating an installation where online visitors touching something in the digital environment can set off a reaction in the physical environment and vice versa. This will be achievable in future iterations of the project.

Broughton's environment was inspired by childhood experience as well as maritime ecology. Her mother was concerned that she needed to learn to swim and brought her snorkelling experiences in the Red Sea. She found the experience troubling because of the water's depth; however, it was also magical to see the multicoloured shoals of fish and to have little turtles swimming alongside. Broughton also wanted to incorporate the idea of fish predating on other fish, and the fragile state of the oceans. She has created an underwater scape of coral citadels with flashes of fish hunting, glimpsed as it were, out of the corner of the viewer's eye.

3.3 Collage, montage, assemblage

The virtual environment affords digital assemblage to generate new simulations. These include textured skins to ornament 3D hollow shapes – creating illusion of volumes turned into mass, fluidity and unpredictability of gas and liquid such as water, mist, fog, the effect of wind through the grass or wheat-fields; gravity, solidity, 'bounceability'- lightness, to conjure up the physical laws within imagined space.

Gunn's practice has involved mixed media and collage for over 40 years. Coming late to new media, these technologies are absorbed in how she always works. Using Tilt Brush, 3D scans, film, sound, her process involves a lot of workaround solutions, a flexible attitude and a delight in problem solving. Collage is an important way of including different perspectives, the lives, the stories and the aesthetics of others.

Kendal and Grant have developed a virtual shoreline. The montage of media types includes 3D vector-based characters and landscape with texture wraps, bitmap painted textures, photographic projections, bitmap photos of physical tangible drawings, soundscape. The shoreline offers regional areas including sand dunes and sand grass, heather walks, bogland forest, bitmap-painted sea waves. The cliffs embed cave paintings depicting mythological stories in remembrance of stories of migration, loss, re-integration and redemption.

3.4 Conversations, communities

Chen, who lives and works in Paris, has brought scientific and design contacts on board, in particular Thomas Picard, Technology Strategy Advisor and Lecturer at Strate Ecole de Design who will coordinate specialist testing with students. She has equally introduced the project to her Taiwanese network where former colleagues will test 'Boundless' with students at National Taiwan University of Arts. Chen is planning to show the 'Boundless' project in a future Smart Cities & Communities exhibition in Paris.

Gunn introduced the project, shared ideas, sent questionnaires and collated user feedback from excluded and hard to reach communities in London and Liverpool with whom she has previously worked. As virtual artist in residence with Museum of Childhood Ireland which actively promotes the rights of children and Elmhurst Primary School, London, she ran presentations and collated feedback from a range of young people. As an associate at Tate Exchange Liverpool, she reached out to fellow Tate Exchange associate Sunil Manghani and brought Winchester College of Art on board as a testing partner – specifically Contemporary Curation MA students. Her upcoming

role as visual artist in residence at the Institute of Irish Studies and multimedia solo show at Victoria Gallery & Museum enabled her to bring University of Liverpool on board as a project partner going forward.

Kendal is in conversation with site-specific communities associated with Dorset coastline's changing ecologies. including Glen Crisford of the National Trust – beaver specialist. Interaction with tester communities / 'communitas' enables conversations that afford transformational values within and beyond the virtual world.

Moore, 2018, refers to Maya Deren's film art and her writings, 1946, on notions of ritualistic art forms. Likewise, the A-Maze artists are aware of creating 'a time out of time', augmented, multi-layered and hybrid perception of reality. For Kendal, Gunn and Kass, there too is an interest in ritual, rites of passage, meditative states, transfigurations, pilgrimage. Resonances between artists and artists communities' working practices, open up shared experience of cyber-consciousness.

3.5 Technical specifications, problem-solving and lessons learnt

3.5.1 Technical specifications.
A-Maze artists have created this virtual world as an all-knowing intelligent planet, with environments that can be explored by sensory humans' visitors with reference to cultural legacies such as Shelley's 'Frankenstein', 1818; Hardy's 'Egdon Heath', 1840-1928; Tarkovsky's Solaris, 1972; Piercy's He, She and It/ Body of Glass, 1993.

Technical specifications are being developed to enrich the users' sensory experience.

1. Pathways and orientation: Fine-tuning transportation bubbles/tunnels. Previously the transportation function was through tunnels, but now through bubbles, this function can be 'juiced' up.

2. Mapping and signposts: Will signposts be needed as guides? Currently spaces/pathways/ doorways are revealed as the visitor freely move around the spaces.

3. Evaluation of User Experience: User walkthroughs and monitoring user activity through the site, can track length of visitor engagement time.

4. Pace and rhythm of movement through the 3D space draws on cultural references. E.g., Kendal draws on the notion of the wanderer with a peripatetic desire from flaneur to visionary (Coverley, 2012) who walks across dynamically changing landscape encountering literally and historical connotations (Hardyment 2012). Sensing textures/ colours/ transparency- opacity e.g. fog, mist, seasonal or daily rhythms, changes in weather, light and opacity.

5. Sense of gravity, bounce-ability, of weight and solidity of objects, the feel of walking /swimming / moving as an avatar.

6. The sense of liminal transitional places between land/water/air/ up in the skies/under the sea, in mist or in clear air. Water/sea/ tides ebb and flow, and rising water levels, being underwater or on the beach /shoreline.

3.5.2 Using Unity
"The major problems in the world are the result of the difference between how nature works, and the way people think", (Bateson, 2000).

Whether creating physical installations, a game or another form of experience it is imperative to consider how the environment will affect the user/participant/perceiver. Most living things are engaging in effortless interactions with their surroundings, through the senses, in both output and input – through actions taken and the responses to the action of other entities. All the senses influence the personal responses to these immediate and live encounters. Unity 3D allowed us to start developing artistic experiences with these sensitivities in mind.

When considering potential immersive, world building tools we required a sweet spot of technical control and, for the artists, creative expression. Due to some A-Maze artists' designing large majorities of their pieces in a VR headset (Tilt Brush) we considered software compatibility, as noted elsewhere.

The decentralised nature of the project (Braidotti, 2018) was integral to this Artists' collective. Shared software platform needs to function simultaneously and globally. Unity enables collaborative working for multiple geographically dispersed designers. However, communication issues alongside various puzzling technical errors have required the team to share large unity projects via google drive due to Mac and Window incompatibility, Plugin transfers among other uncanny technical errors.

An important component to acknowledge is the online Unity forum community of largely anonymous helpers who have played an integral role in solving some of the issues we have faced. From the Open Brush, 2022, giving clear instructions on how to integrate Tilt Brush with Unity to the Stack Overflow,

2022 community responding to various questions posted.

3.5.3 Lighting
Linowes, 2021 in 'Lighting, Rendering, Realism, notes the challenges of a lot of runtime processing overhead that can create a negative impact on user experience. We need to make design decisions, based on narrative choices, often trade-offs between realistic details and smooth user experience.

When the development team was introduced to the project in September 2021, HDRI's were introduced as skyboxes. These are panoramic photos that contain large amounts of light data which can help illuminate a 3D scene. This method has two main positives. Firstly, lighting in this way is easier on a computer to process. Our goal was to make the artworks accessible to a wider variety of computer types. This way of lighting creates a symbiosis between processing finesse and aesthetic quality we strived for.

Secondly, having this consistent and detailed lighting starts to help avoid harsh and inconsistent lighting. In Unity, if a scene uses multiple light sources, the lights can sometimes sporadically turn on and off. This can happen quite abruptly. Part of the core intention of the technical development was to create something that was smooth and playable. Both for aesthetic sensibility and to achieve an inclusive experience accommodating sensory processing needs. Optimising the lighting in this way helped us move a little closer to achieving this intention. With some way to go still.

3.5.4 360 environment, skyboxes
Experiments e.g., with SkyBoxes, Shaders, Reflections, 360 Degrees, 'fog and mist'; hover/select/activate; visual traces; light emission and reflections 'juices' up the experience and gameplay. E.g., note the Visual effects used in Doug Aiken's: *Metallic Sleep, 2022*, 'a digital sculpture of interlocking oval mirrors, stands in the centre of a small arena surrounded by a high concrete wall, above which a twilit sky shifts in an unreal wind' (ArtNet 2022).

3.5.5 WebGL
Hudson, 2022, has been problem-solving WebGL to facilitate easy web access. In order to make the world accessible, a web-based solution can eliminate many of the problems associated with developing different versions for different target platforms e.g., Windows, Apple, Android. Having the work online also allows for quicker access to the work without having to download the whole application. The work can be split up scene by scene, only downloading the scenes the viewer wants.

One issue that was raised when using the WebGL format was using Tilt Brush. Some of the shaders that are part of the software use audio input; the Tilt Brush SDK therefore has code to allow these to function. WebGL doesn't allow audio input since it presents certain security risks. Thankfully the Open Brush website provided detailed instructions on how to upload to online applications – Refer to STYLY section (Open Brush, 2022).

3.5.6 Importing Tilt Brush assets
As an integral part of their creative process, Gunn designed her artwork, the participant space and the hub in Tilt Brush. The file format for this software is GLB. Importing these files into Unity can be problematic. The TiltBrush SDK, available free from GitHub, combined with Open Brush's online step by step guide we were able to integrate these file types into Unity. However, Tilt Brush creates their own shaders, or materials which created some developmental issues. Firstly, due to many of the brushes creating quite high polygon objects – the geometric shapes that make up 3D objects – as well as complex procedural shaders (moving and animated) resulted in a requirement to optimise a little heavier than other scenes needed. This was done by combining two plugins, PolyFew and Amplify Impostors. The Impostors plugin was used to replicate objects that were used repetitively, turning 1000 polygon objects to 10 polygon objects. Secondly, when creating interactions in the participant space we experienced a lot of difficulties. E.g., creating interactions whereby individual trees' material would change when touched or clicked on. Due to unclear file naming systems from Tilt Brush the interactions would change sporadically. A tree would be clicked, and an interaction triggered but, unfortunately, change the material of a different unintended tree elsewhere in the forest. We are still currently searching for the solution for this particular complication.

3.5.7 Importing Maya assets
3D Maya assets have been imported into Unity. E.g., Broughton's self-created animated fishes. James and Grant are working on animated beavers.

3.5.8 Importing libraries
Libraries of textures and flora are imported from within Unity or external suppliers, Grant 2021/2022**.**

3.5.9 Using the Universal Render Pipeline

Different pipelines are available from 2019, (Linowes, 2020):

(i) Built-in Render Pipeline BIRP

(ii) Universal Render Pipeline URP

(iii) High-Definition Render Pipeline HDRP

(iv) Scriptable Render Pipeline SRP which allows customisation using C#

During integration stage, A-Maze design-developer team have investigated different render pipelines and resulting incompatibilities/ compatibilities.

3.5.10 Juicing up the scenes
Future development includes enlivening the scene, so the environment feels alive, responsive to the user's 'touch' and 'feelings'.

Gunn's scenes offer the user trips through a roller coaster suspended above a dynamic swirling sea; In Chen and Broughton's spaces, marine environment is experienced from under the sea. Parvez's scenes offer the user the sensory juxtaposition of urban experience with walking through the wheat-fields. Kendal's scenes encourage a walking meander through diverse terrains and textures of shoreline.

3.5.11 Team-working and online community-learning
The decentralising aspect of team-working has afforded a major challenge at the integration phase. The open approach of different artists working separately on Unity is similar to the open approach of decolonising cultures. In order to meet the challenges of different Unity set ups, a further integration testing phase has been required. Moreover, unlike a commercial set up, artists, designer-developers are all working from within their personal home studios, without the support of a professional development service team. Problem-solving, whilst referring to industry forums, is achieved in-house across the team Kass, 2022).

3.5.12 Testing
At this early stage of testing, A-Maze artists offer simulated movies of visitors' experiences. Conceptually, aesthetically and technically, the early movies made in June 2020 have evolved radically from the movie simulations generated in February 2022. Now movie stimulations use animation key frame techniques from specified coordinates and camera view positions. (Grant and team 2022)

3.6 Supporters

3.6.1 Collaborators

- Thomas Picard – Technical Strategy Advisor/ Lecturer at Strate School, Paris
- Sean Rodrigo Immersive Artist / XR Tutor / Creative Technology Consultant, UK
- Paul James, Digital Content Designer, C3 Studios. UK
- Professor Sunil Manghani, Winchester School of Art, UK

3.6.2 Schools
A-Maze have carried out iterative testing with Elmhurst Primary School, online presentation followed by questionnaires distributed and collated in combined art/technology classes. The school will continue as a testing partner going forward and we are also identifying other school partners in Liverpool specifically.

3.6.3 Higher education
Through the Tate Exchange and Gunn's role as a Tate Associate, a fellow Tate Associate, Professor Sunil Manghani met and invited the A-Maze artists to present the project to a group of postgraduate artists from Winchester College of Art.

4. SUMMARY AND NEXT STEPS

The 'Boundless' project is some way from the end of the beginning, and we've learned many things we wish we'd known before we started. However, our instincts about digital inclusivity are proving right; gaming technology has wider cultural applications, artists can find workaround solutions, diverse perspectives, complex and subtle visual narratives can lead to more satisfying user experience and deeper engagement.

Embracing new media and technologies allows cultural institutions to decolonise their collections in creative ways, enriching their role in society rather than impoverishing it. From the artists' perspective, this allows greater freedom to engage with diverse communities, to have access to spaces which were not available before, to communicate directly and ethically with audiences and to not have their artworks mitigated or watered down by institutions.

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Adaptive VR Test in Music Harmony Based on Conditional Spiking GAN

Anna Shvets
Fablab by Inetum
157 Boulevard MacDonald
75019 Paris, France
anna.shvets@inetum.com

Samer Darkazanli
iMSA
Rue Clos Maury 82000 Montauban,
France
darkazanli.samer@imsa.msa.fr

This article proposes an adaptive VR test for the knowledge level control in music harmony. The core functioning relies on conditional semantic music generation strategy, using spiking conditional GAN architecture. The novel method of semantic music information encoding based on the system of graphs in music harmony, allowed two-dimensional data representation of harmonic sequences. which made possible considerable data augmentation and a transition to the specifics of training inherent to the visual domain. To our best knowledge, this is the first attempt of conditional spiking GAN implementation along with the application of the spiking neural networks in a domain of semantic music generation.

Adaptive test. VR. AI. Conditional Spiking GAN. Semantic music generation. Graphs in music harmony.

1. INTRODUCTION

The search for sustainable and scalable calculation platforms led to the emergence of neuromorphic devices along with neuromorphic computing methods. The biologically plausible spiking neural networks (SNNs), considered as the 3rd generation of artificial neural networks, represent a viable alternative to the 2nd generation artificial neural networks (ANNs), as their structure and functioning are in a direct correspondence with the goals and technical possibilities of the neuromorphic devices. There are three strategies for spiking neural networks training, which comprise *a posteriori* conversion of a trained ANN into SNN (Massa et al. 2020, Diehl et al. 2016), designing and training SNNs in a spiking domain on conventional computing platforms, such as GPU or TPU (Rathi & Roy 2020) and training SNNs directly on low power devices (Akbarzadeh-Sherbaf, Safari & Vahabie 2020). In this article we exploit the second strategy, designing a conditional spiking GAN, training it on a GPU platform and integrating a trained model into an adaptive VR test scenario.

2. STATE OF THE ART

2.1 Spiking neural networks

2.1.1 Encoding strategies
The ways of the information encoding strategies, since the appearance of the first scientific model of spiking neural networks (SNNs) in 1952, comprise binary coding, rate coding, latency coding and fully temporal codes. The information encoding influences the learning methods taxonomy discussed below.

2.1.2 Learning methods
The application of the training strategy for SNNs depends on the nature of the problem and can be solved with unsupervised, supervised and reinforcement learning. The set of unsupervised learning methods comprise spike-timing-dependent plasticity – STDP rule (Caporale & Dan 2008), Growing Spiking Neural Networks (Hazan et al. 2008), Hebbian learning rule (Hebb 1949) with two derivatives - Artola, Bröcher, Singer – ABS rule (Artola & Singer 1993) and Bienenstock, Cooper, Munro – BCM rule (Bienenstock, Cooper & Munro 1982). Among them, the most used method is the STDP, which implies that the weight (synaptic efficacy) connecting pre--synaptic and post-synaptic neurons is altered based on their relative spike times, thus the weight adjustment is made using local information in terms of synapse and time.

The supervised learning methods comprise SpikeProp (Bohté, Kok & Poutré 2000), Remote Supervised Method – ReSuMe (Ponulak & Kasinski 2006), FreqProp (Bogacz, Brown & Giraud-Carrier 2000) and Local Error-Driven Associative

Biologically Realistic Algorithm – LEABRA (O'Reilly 1996). More recently, a latency-based backpropagation for static stimuli – S4NN with surrogate gradient learning (Kheradpisheh & Masquelier 2020), binarized spiking neural networks with temporal coding and learning - BS4NN (Kheradpisheh, Mirsadeghi, & Masquelier 2021) and rectified linear postsynaptic potential function (Zhang et al. 2021) have proposed a viable alternative to the existing methods, by adapting backpropagation algorithm to the SNN training specifics.

Finally, the reinforcement learning makes usage of the spiking actor-critic method (Potjans, Morrison & Diesmann 2009) and through reward-modulated STDP (Florian 2007).

2.1.3 SNN neuron architecture

The mathematical formalism of the biological SNN neurons can be divided into two groups: conductance-based models and threshold models. Conductance-based models, such as Hodgkin-Huxley model (Hodgkin & Huxley 1952), FitzHugh–Nagumo model (Fitzhugh 1961), Morris–Lecar model (Morris & Lecar 1981), Hindmarsh–Rose model (Hindmarsh & Rose 1984), Izhikevich model (Izhikevich 2003) or Cable theory (Tuckwell 1988), describe the initiation and propagation of the action potentials in neurons, while threshold models, such as perfect (non-leaky) integrate-and-fire, leaky integrate-and-fire (Delorme et al. 1999) or adaptive exponential integrate-and-fire (Brette & Gerstner 2005), generate an impulse while a certain threshold is reached. Recent research is mostly exploits the threshold models, as per the simplicity of their calculation.

2.1.4 Network architectures

The integration of the SNN neurons has been tested with classical feedforward (dense) neural networks (She 2020), recurrent neural networks (Demirag et al. 2021, Kim & Sejnowski 2019), convolutional neural networks (Guan & Mo 2020) and belief neural networks (O'Connor et al. 2013). The SNN layers were also applied within generative adversarial network architecture and are discussed below.

2.2 Conditional music generation and generative potential of SNNs

2.2.1 Conditional music generation

The attempts to control the generated samples may be divided into three groups – conditional, controllable and constraint generation. The conditional generation takes one element to generate another (Liu & Yang 2018, Yu & Canales 2021), while controllable generation uses the input features change to manipulate some aspects of the output generation (Wang et al. 2020, Tan & Herremans 2020). Finally, the constraint generation exploits the template-based approach to influence a shape of the output result (Lattner, Grachten & Widmer 2016). The controllability research mainly focuses on the features disentanglement, proposing systematic studies (Pati & Lerch 2021) and datasets (Pati, Gururani & Lerch 2020), designed to foster further experiments in the field. The existing resources, however, gather monophonic music examples only and are not suitable for harmonic sequences studies.

The research in conditional music generation presents a plethora of generative architectures: LSTM, Transformer (Makris, Agres & Herremans 2021), GAN (Liu & Yang 2018, Shvets & Darkazanli 2021), hybrid versions, such as LSTM-GAN (Yu & Canales 2021) or GAN with an inception model (Li & Sung 2021), the latter architecture makes use of the convolutional layers, followed by the time distribution layer that considers sequential data, forcing the convolutional layers consider the time relationship in a manner similar to RNN layers do. The above-mentioned approaches make use of the time information encoding and this is an important point of attachment with the spiking neural networks, which are intrinsically sensitive to the temporal characteristics of information transmission (Tavanaei et al. 2019).

2.2.2 Spiking GANs

The current state of art in the application of spiking layers inside a GAN architecture accounts only three experiments – Spike-GAN (Molano-Mazon et al. 2018), Spiking-GAN (Kotariya & Ganguly 2021) and SpikeGAN (Rosenfeld, Simeone & Rajendran 2021).

The purpose of the Spike-GAN consisted in synthesizing of neural responses that approximate the statistics of the realistic neural activity, being trained on a real dataset recorded from the salamander retina (8192 samples) in a form of one-dimensional matrices of size $N \times T$, where N represents the number of neurons and T stands for the number of time bins during which the spikes occurred. Thus, the architecture of the Spike-GAN consisted of the discriminator with 1D convolutional layers (256 and 512 features, respectively), followed by a linear layer, along with a mirrored generator architecture sampling from a 128-dimension uniform distribution. The LeakyReLU activation function was used consistently through the network.

Spiking-GAN, instead of approximating neural activity and retrieving its heat maps, applies spiking learning strategy to the generation of examples inherent to a visual domain, using standard MNIST dataset (60 000 training examples). The experiment is based on Time-to-first-spike (TTFS)

temporal coding and the least-squares loss applied in the temporal domain. The Spiking-GAN architecture makes use of the dense layers: 2-layer fully connected network for generator (100-400-784) and discriminator (784-400-2). The latter takes a flattened spike train, encoded with TTFS coding, as an input. The output neurons of generator and discriminator are using tangent and sigmoid activation functions respectively. The rest of the activations used through the network are ReLU.

Finally, SpikeGAN aims matching the distribution of the SNN outputs with a target distribution, regardless of the data nature, being trained consistently on handwritten digits, simulated spike-domain handwritten digits and synthetic temporal data. SpikeGAN exploits a hybrid architecture with a spiking generator and conventional ANN discriminator.

None of the above-mentioned experiments, however, proposed a conditional spiking GAN architecture applied in a field of semantic music generation.

3. ADAPTIVE TEST DESCRIPTION

3.1 Methodological context

This proposal is based on a new system of representation, which lifts a cognitive load regarding the understanding of harmonic logic and chord structure, facilitating the assimilation of knowledge in musical harmony and the formation of audio skills. The method itself is based on a graph theory (Minsky 1974) and uses of the original mapping of colour to the functions of music harmony and to the chord structure. The effectiveness of this representation methodology has been proven efficient in a multi-step educational experiment on hybrid learning, showing a substantial increase of the quality of knowledge with the system application (Pistone & Shvets 2014, Jemielnik & Shvets 2015, Shvets 2019). The method was used to build graphic interface of the award-winning mobile and VR applications (Shvets 2016, Shvets & Darkazanli 2020).

3.2 Functioning scheme

The technical issues of implementing an adaptive test in music harmony previously was linked to the absence of reliable techniques for the semantic music content generation conditioned by the user's knowledge. In the present proposal, this problem is solved with the generative neural network with the conditional spiking GAN architecture, which takes the first chord as an input and generates a sequence of five chords. A conditional GAN with the similar functioning was proposed in 2021 (Shvets & Darkazanli 2021) and consisted of convolutional 1D layers, being integrated into a practice room of the VR applicating “Graphs in music harmony”. In the present model, we add spiking layers, which improve learning spatiotemporal relationships and therefore memorizing the position of the chord in the sequence. The integration of this technology into the adaptive testing process consists of the following steps:

(i) Analysis of user data to define the set of chords that the user has already learned, using the internal storage of the VR application.
(ii) Generation of the harmonic sequence by the GAN model trained and deployed in the cloud, conditioned by the analysis of the learned chords. The data exchange protocol uses JSON format to send the user data and receive a generated sequence.
(iii) The sequence received from the model in a JSON format is mapped to a 3D representation of chords in a VR space, using the internal mapping rules. The object of the test (a chord) is replaced by a question mark symbol on the staff modelled in a VR space and the audio of the harmonic sequence, constructed from the VR application's internal sound library, is played to the user.
(iv) The user chooses a chord from the graph, which matches the chord hidden by a question mark, played to the user previously. The VR application compares user input with the information received from the model.
(v) Depending on the correctness of the response, the VR test shows a chosen chord within the graph sequence (Fig. 2) and sends a new request to the generative model for generation of a new harmonic sequence. The generation might be requested either with another test object (a hidden chord), among those which should be learned in a lesson (in case of the correct answer), or for the same test object - the chord which was not recognised by the user (in case of the incorrect answer).
(vi) The transition to the end of the session is made after several repetitions of the step 3 (this number is defined by the number of chords to be learned per lesson), if all the answers are correct, or after the same number of repetitions, multiplied by the number of incorrect answers from the user.

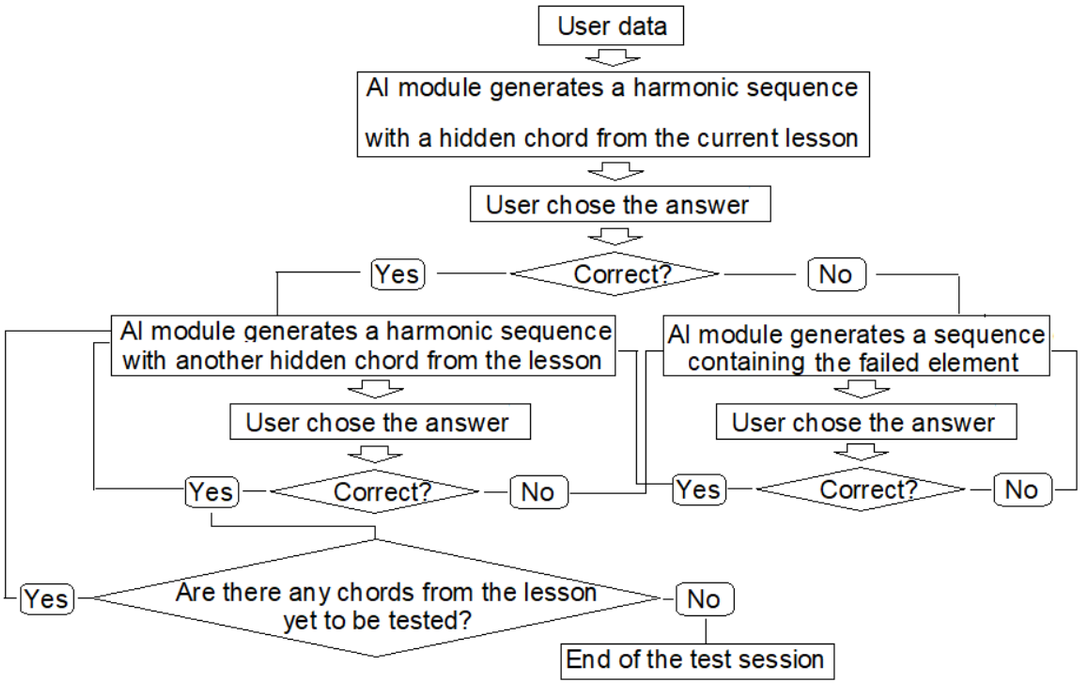

Figure 1: *Scheme of functioning*

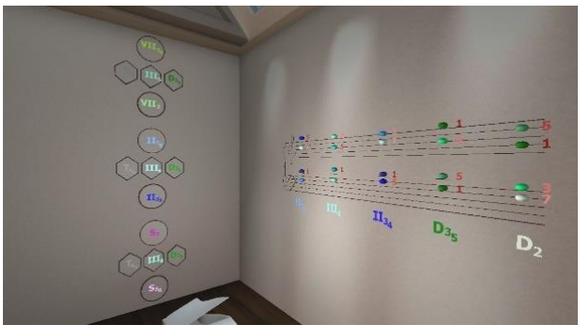

Figure 2: *Screenshot of the answer*

3.3 Individual tones interactivity

To increase the immersion effect, the interactivity with the individual tones of the chord has been introduced. This feature allows the feedback reception (sound and vibration) after touching different tones of the chord. The feature became technically possible with the Oculus Quest 2 controller. This will allow the increased tangibility of chords and the possibility of audio separation of different chord tones, explaining the chord phonism.

4. CONDITIONAL SPIKING GAN

4.1 Data encoding

Since the nature of the model purpose, which consists in inclusion of chords learned during the lesson, each harmonic progression must contain the passing progression in a single tonality – C major. This very rigid limitation induced the necessity of manual data crafting and a search for the effective augmentation techniques. In this context, we propose a new encoding strategy, which converts one-dimensional textual data (analytical representation of a harmonic sequence) into two-dimensional spike trains. The base for the dimensionality shift is the conversion of the harmonic sequences to their matrix representation within the system of graphs. In order to perform a dimensionality transition, the following steps should be made:

(i) Mapping of each chord of the harmonic sequence in its analytical semantic representation to the numerical representation – respective pointer indexes;
(i) Finding a corresponding chord within the system of graphs and replacing it with the mapped numerical value;
(ii) Applying a varying normalization term of a small value (1^{-2}) to augment the data.

To illustrate the described transition process, let us take a sequence of three chords II_7-VI_{46}-II_{56} and present it as a graph (Fig. 3a), then replace a semantic chord designation with numerical values – indexes we chose to represent the chords (Fig. 3b): we thus receive a 3x3 matrix. If we repeat the described procedure, but taking the dimensionality

of the whole system, we receive a 28x28 matrix, which becomes a feature map to the neural network (the 49 chords of the system of graphs are giving precisely 27x21 matrix, however we added one column and seven rows of a padding filled with zeros to facilitate computing of the 2D convolutional operations within the neural network).

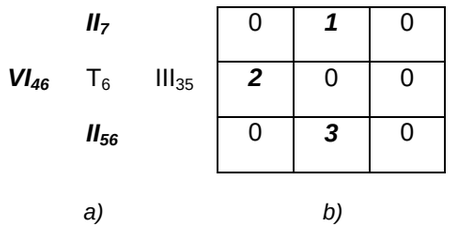

Figure 3: *Harmonic sequence in a graph representation (a) and in a matrix representation (b).*

The normalization variation allowed to augment the data from 216 manually crafted harmonic sequences of 5 chords each to 2160 matrices of training data. The sparsity of data points in each of the matrices is coherent with the advantage of spiking models, which is temporal sparsity – the fig. 4 shows a visualisation of such sparsity within ten matrices.

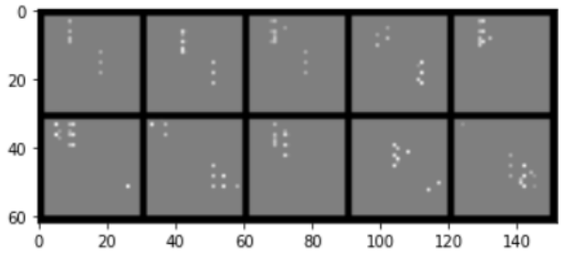

Figure 4: *Ten harmonic sequences visualised as a features map in ten matrices.*

4.2 Network architecture

The network was implemented with the use of Pytorch and PyTorch-Spiking library developed by Nengo.AI group. The latter framework allows transforming standard Pytorch activation functions into spiking layers with the possibility to use the spiking activations on the forward pass, using user defined time steps, and the non-spiking activation function on the backward pass, which overcomes the non-differentiability problem of spiking neural networks.

The generator model consists of a tripled stack of convolutional transposed 2D layer and a spiking layer (a ReLU activation function wrapper), the last stack contains convolutional 2D layer coupled with the tangent activation function wrapped into a spiking layer.

The discriminator model comprises two stacks of convolutional 2D layers followed spiking LeakyReLu activation layers with the slope of 0.2 and a final convolutional 2D layer.

The hyperparameters included Adam optimiser with the learning rate of 0.0001 and BCEWithLogitsLoss as a loss function for both models. Batch size was equal to 64 data examples, the time steps (an important hyperparameter for spiking layers) for a forward pass was set to a value of 100 in both – the generator and discriminator models, the number of training epochs totalled to 200. The weights of the convolutional layers were initialised from a zero-centered normal distribution with standard deviation 0.02.

4.3 Training results and discussion

The very first prototype of the network doesn't converge yet well enough, with the generator being inferior in performance comparing to the discriminator. There are therefore a room for amelioration which might be accomplished with the application of the surrogate backpropagation methods (spiking aware backpropagation) and a plethora of conventional GAN stabilization methods, such as earth mover's distance algorithm, Lipschitz continuity and more recent regularization methods (Lee & Seok 2020), since the semantic music modality being transformed to a visual modality with the proposed encoding technique, may benefit from the discoveries made for GANs in a visual domain.

5. SUMMARY

The article presented an adaptive VR test in music harmony, based on the original representation methodology, employing colour and colour shades for harmonic function and chord structure representation respectively, lifting the visual cognitive load for the learner while auditory adoption of new chords and harmonic sequences. The generative mechanism of the test is based on conditional convolutional spiking GAN for semantic music generation. Novel encoding strategy allowed transforming one-dimension array of the sequence into two-dimensional representation, using the position of each chord in a system of graphs in music harmony, which allowed a considerable data augmentation. The work presents a significant step in research of spiking neural network paradigms application to the problematics of semantic music generation.

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Action at a Distance: Altered states through virtual gestures and audio-visuals

Leslie Deere
Glasgow School of Art
167 Renfrew St, Glasgow G3 6RQ, UK
L.Deere@gsa.ac.uk

1. INTRODUCTION

Array Infinitive is a project that examines the role of audio-visuals in VR practice. This studio-led work focuses on amplified audio and VR visuals generated, processed and 'played' via gesture to a locally networked audience. For this project I am researcher, lead artist, composer and performer. I use hand gestures and bodily movements to create sounds and VR particle trails, which are broadcast to audience VR headsets in real-time.

This research looks at the exploration of presence, embodiment, corporeality and spatiality of performance in the writing of Erika Fisher-Lichte. During the 'enlivening' of a room into a performance space, live action widens potentials in perception and expands the relationship between performer and audience (Fisher-Lichte p.107). Through this research there is an intent to 'activate' dual spatial planes, both of the virtual and real-world encounter; to create a group experience and to explore affect and altered states of consciousness.

Reference is taken from the Virtual Reality and immersive performance assertions of Shi Ke's *Embodiment and Disembodiment in Live Art*, which approaches VR as a transcendental format capable of maintaining autonomy, while quoting Donna Haraway with 'the boundary between science fiction and social reality is an optical illusion' (1991, p.149) (Ke 2020, p.193). Jonathan Weinel's *Altered States of Consciousness in Electronic Music and Audio-Visual Media* is a touchstone for this work. This includes ASC simulations and the potentials for therapeutic purposes and as possible useful tools that promote awareness of these states within society (Weinel 2018, p.165). In addition, focus has been placed on the affect theory research of Gregory J. Seigworth and Melissa Gregg's 'mattering maps', which include attention, moods or orientation (Grossberg 2010, p. 310).

This paper focuses on qualitative data obtained during the official controlled pilot and public beta exhibition of *Array Infinitive*, which took place at the Centre for Contemporary Art in Glasgow (July 2021). For the pilot I used self-reporting feedback questionnaires as well as the 11D-ASC and MODTAS to measure ASC.

2. PILOT TESTS

Key pilot tests occurred in July 2021 at the Intermedia Lab of the Centre for Contemporary Art, Glasgow. An assistant and I saw a total of twenty-five participants over the four-day period. Participants were sat in chairs, of which there were four facing each other, in a diamond shape. The audio-visual VR experience was conducted, lasting around fifteen minutes. Afterwards participants filled out three forms, which included a text-based feedback form, the MODTAS questionnaire and the 11D-ASC questionnaire. The MODTAS (Modified Tellegen Absorption Scale) measures levels of sensorial absorption. The 11D-ASC scale measures Altered States of Consciousness and includes marking a scale between 'no, not more than usual 'and 'yes, very much more than usual'. Dr David Luke (University of Greenwich) advised on the ASC measurement. The written feedback form aimed to investigate participants reactions to the VR work, participant relationship to the group, to the sound, and to the performer.

The ages of pilot test participants ranged from nineteen to eighty and included mixed gender male, female, non-binary and neurodivergent identifying persons. After sessions, participants verbally shared further information, thoughts and feelings. This is how I am aware of participants' specialised

identification, as I had not asked about this on the participant information forms.

Key aims of the pilot tests were to measure participant response to the VR experience, and discover if the work is capable of generating an altered state experience. In addition, data was collected around perception and experience through the technology, evaluation of the group dynamic and ascertaining the level of awareness between human and technical involvement.

Figure 1: *Pilot Tests, July 2021, Intermedia Lab, CCA Glasgow.*

3. EVALUATION

The key areas of enquiry focus on awareness of human involvement during the VR experience, level of awareness of group activity, and achievement of an ASC encounter.

This controlled pilot test showed that participants are generally not conscious of a human performer controlling the VR experience. 68% of people were not aware a human was playing the audio-visual content. There is some indication that audience profile has an impact on certain aspects of interpretation, such as participants who had a greater awareness of technology were more likely to imagine or assume a person was controlling or playing the content being relayed to them in real-time. 72% of participants said they were not aware of being part of a group during the experience. Visual markers placed in the virtual environment, which were meant to echo the audience positions in the physical space, were not obvious to most participants. Generally, feedback included being ‘lost in the experience’ so that there was ‘no feeling of others’. There was a high majority of 80% who enjoyed the mixed reality experience of having audio amplified into the room, whilst being visually in a VR environment. The audio element of this experience proved to be important. Broadly speaking, the feedback suggests the work does relax participants and creates a safe space to enter into such a state. Verbal feedback was received on comfortability and the work reminding participants of psychedelic experiences and exploring that realm in a ‘safe space’.

The level of immersion that occurs with this project, is such that there is a threshold of attention or bandwidth of noticeability. The sensory input is considerable, and has a maximum number of aspects that can be absorbed at one time. Hence the lack of notice of fellow participants or who / what was controlling the experience. Those details were not considered by the participants while being immersed in the work visually and sonically. Several of the questionnaires came back with ‘slightly anxious’ experiences in the first few scenes, which changed over time, where there appears to be a ‘settling into’ the experience and a more relaxed state with the continuing scenes including reactions such as: ‘Really happy, at peace’, ‘Euphoric’, ‘A feeling of awe’, and ‘Exhilarating like all things were possible’.

This sensory aspect also led to participants entering into a genuine altered state experience. Much higher levels of ‘simple imagery’ and ‘bliss state’ were achieved, as can be seen in contrasting non-drug ASC experiments graph. The indicating factors of immersion and audio-visual affect contributed to audience having an altered state experience, even if it was singular or subjective rather than immediately noticeable as part of a group.

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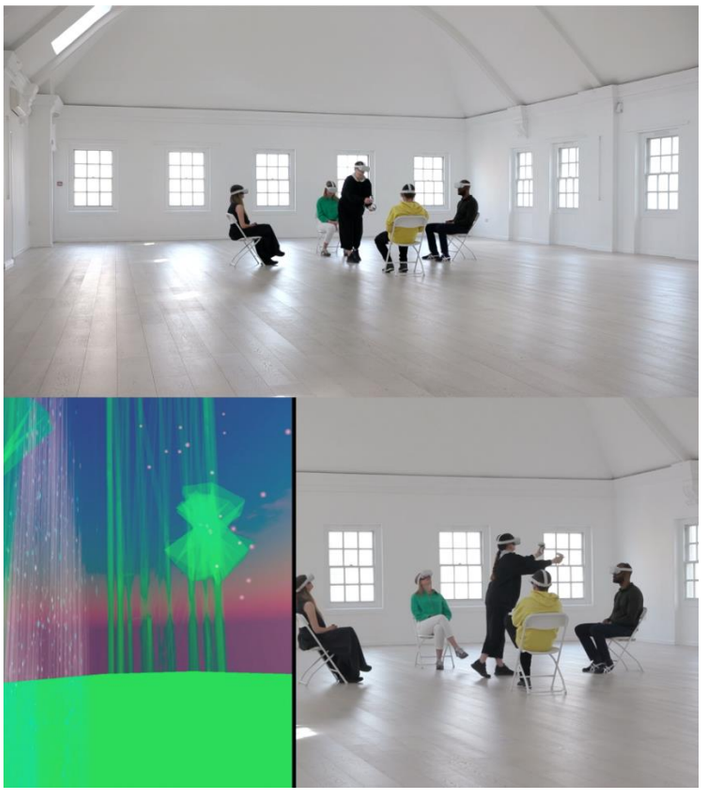

Figure 2: *Still from Mind the Film videography of Array Infinitive at Core Studios London, 2021.*

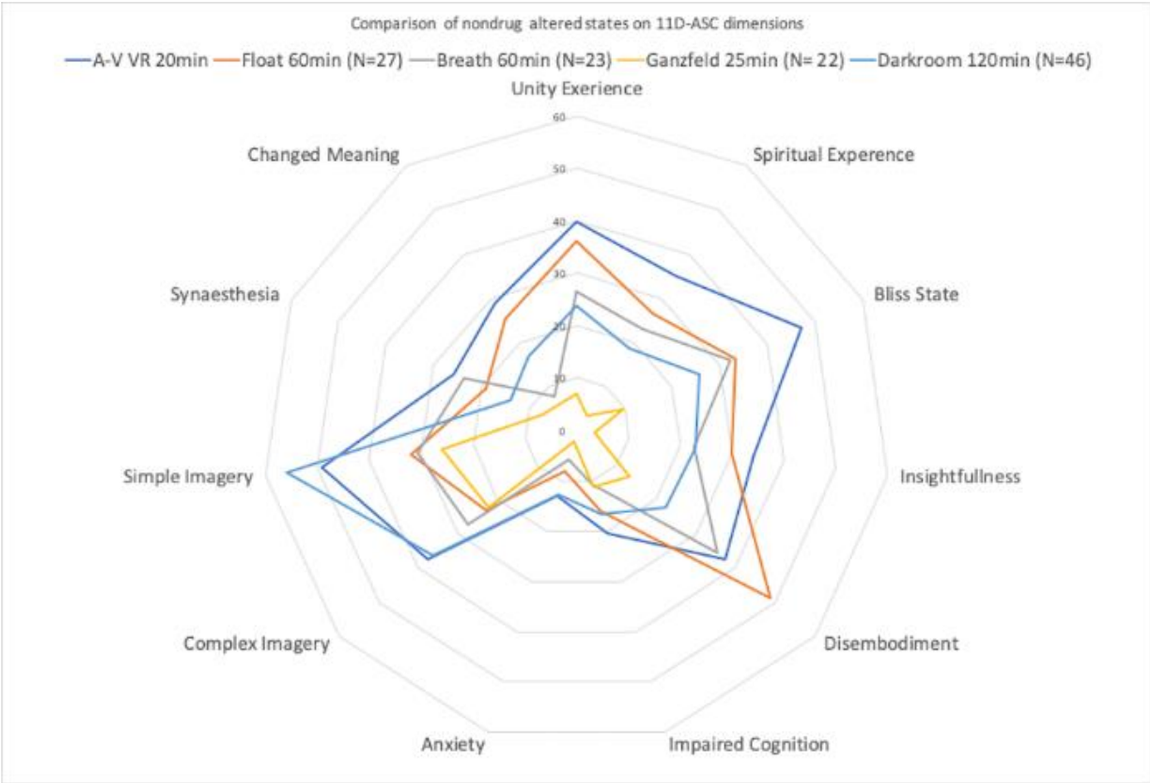

Figure 3: *ASC data results from Pilot at CCA Glasgow.*

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The Gamification of Arts and Culture: The expanded narrative and the virtual space from digital media to COVID

Joanne Mills
University of Wolverhampton,
UK
j.t.mills@wlv.ac.uk

This paper considers how advances in technology towards the end of the twentieth century led both to new affordances in immersive experiences at the intersection of art, design, and technology (for example virtual reality), and came into their own during the COVID-19 pandemic through the creation of innovative, engaging works. The concept of an expanded narrative is presented as existing outside of the work itself, as the relationship between audience, artwork and the space in which it is presented – and by acknowledging how screen-based experiences become both accessible, affordable, and pervasive within society, this paper suggests a potential gamification of culture to bring art and entertainment to new audiences.

Immersion. Audience. Technology. Digital. Gamification.

1. INTRODUCTION

This research arose from a doctoral investigation into the historical precedents of contemporary immersive artistic experiences, considering the 1960s to the present day. In examining how changing technologies allowed for collaboration, multi-disciplinary artworks, and immersion, it is therefore relevant to consider the global need for (and uses of) digital technology during the COVID pandemic. This research is presented through the concept of the expanded narrative, which exists outside of the work itself, concerning the relationship between audience, work, and the environment in which it is presented. A distinction is also noted between the 'immersive artistic experience' (as being specifically related to the arts), and the broader 'immersive experience' (which has a wider connotation, of being related to social, commercial, educational purposes, for example)

Peter Bürger's Theory of the Avant-Garde was written in the 1970s and deals with the historical avant-garde of the 1920s and 1930s, and its attempts to reconnect art and 'life'. In the text, Bürger draws a link between the genre and political engagement through socially engaged practice. The audience (or the spectator) is placed in an active role of recipient and conduit of the message or meaning of the work, viewing it through the lens of their own subjective experience. Boris Groys observes that the internet allows for the realization of "the avant-garde impulse", with art (as data) being placed in the context of reality (Groys 2016, p174). Although referring to its reproducibility, Groys' posits that by its very nature (of, for example, a digital image being merely a visualisation of data) "digitalization turns visual arts into performing arts" in the same way that sheet music needs to be performed in order to be experienced (Ibid., p143). He also recognises that the experience of the digital work is dependent on the software and manner with which it is viewed, and requires what he terms as an 'act of interpretation' (of its form) from this viewer.

According to Groys', "[these] digitalized images do not exist unless we as users give them a certain 'here and now'", indicating that works requiring the presence or action of an audience cease to fully exist without one (Ibid.). Groys' further notes that our actions in the digital realm, whether on our own computers or behind our own doors, are fully visible

to a 'universal spectator', leaving traces of the movements and interactions of our virtual counterparts (Ibid., p145). This concept is of relevance in the increasingly online world we inhabit because of COVID.

2. THE EXPANDED NARRATIVE

Artistic shifts during the 1960s led to a more active role of the audience, and the blurring of the boundaries between media and the artistic space, leading to the development of what I term an expanded narrative. This expanded narrative exists outside of the work itself, with regards to the relationship between audience, work and environment, and is here presented as arising from the incorporation of three elements:

(i) Active space – implying a purposefully constructed or controlled environment (or one which has been chosen specifically for its value or contribution to the finished work/performance). Such spaces include installation artworks or environments, for example Olafur Eliasson's *The Weather Project* and Yayoi Kusama's *Infinity Mirror Rooms*.
(ii) Collaboration – between disciplines, between creator and audience, or between individuals. Examples include the historic works of Experiments in Art and Technology (E.A.T.), and Terry Riley's *Time Lag Accumulator*.
(iii) Active audience – undertaking an exploratory or participative role, for example audiences attending performances by Punchdrunk, or the happenings of the 1950s and 1960s.

The term 'active space' is used to imply a purposefully constructed or controlled environment (or one which has been chosen specifically for its value or contribution to the finished work/performance); while an 'active audience' has agency within (or contributes to) a work. A subjective relationship or expanded narrative between an active audience and artwork allows for the freedom to create individual understanding and interpretation through participation and engagement within the boundaries of the work or performance. These constructed 'active spaces' then allow for other affordances such as movement or participation, resulting in an immersive experience for a deeper engagement with the performance/artwork.

This paper focuses in particular on the virtual as a contemporary form of active space, and the ways in which audiences engage with such spaces – further suggesting that our experiences with computer-based communication, information and games has led to a 'gamification' of arts and culture which allows both for a sense of ease and familiarity with navigation and experience of screen-based works, and for engaging new audiences. Further, the relevance and importance of online communication and experience within our mid-pandemic world is recognised – together with ways in which technology can be utilised as part of our 'new normal' to ensure the continued access to and engagement with arts and culture.

3. THE VIRTUAL AS ACTIVE SPACE

While the forms of participation with (and engagement of) an active audience traditionally resided within physical spaces, the advancement towards digital forms of practice brought new methods of enabling audience involvement. Frank Popper recognises this when he describes technologically driven art as being intrinsically about involving the audience in the process of creation and making a conscious move from participation to interaction (Popper 1993).

From the 1980s, artists were looking to the potential of computers and the internet to realise their ideas. Early pioneers of net.art included Vuk Ćosić, Alexei Shuglin and Olia Lialina, while others came from a computing background, for example John Klima. The movement was inexpensive and accessible to anyone with a computer, modem and internet connection (either at home or in a public space such as a library). As Mark Tribe (2006) noted,

> New Media artists saw the internet much as their predecessors saw the portable video camera: as an accessible artistic tool that enabled them to explore the changing relationship between technology and culture.

New Media Art allowed artists to respond to the advance of information technology and digital culture, for example Christa Sommerer and Laurent Mignonneau's *A-Volve* (1994), an interactive real-time environment in which visitors interacted with virtual creatures in a water-filled glass pool.

The emergence of interactive digital artworks brought with it new problems. Such works were medium specific and time-based, raising issues of how to display, curate and archive them. Unlike paintings and sculpture, these works required audience engagement to reveal their content, and flexible and responsive methods of presentation were often required. The movement from interactivity within physical spaces to those digitally created (and/or enhanced) and held within a computer marks a shift from the audience being present in the same location as a work to what Edwina Bartlem (2005) terms "spaces within spaces", and towards virtual environments where through technology, the space of the spectator is

extended beyond a screen to a digitally constructed work. Additionally, intuitive interfaces encourage and welcome the exploration and action of the audience, where the experience is shaped by the collaboration between audience and artwork. While internet-based art works raise issues of uniqueness, ownership, and reproducibility, they also enabled new forms of production, not just reproduction. Similarly, virtual reality can both be used for creation and recreation (for example of a building, person or object – as with photography, painting, and other more traditional artistic forms).

Early forms of virtual spaces were presented within small cinema attractions between the 1970s and 1990s, such as the Omnimax (since renamed as IMAX dome) theatres, which showed films projected onto the curved ceiling of the venue. In 1988, Scott Fisher of the University of Southern California and Elisabeth Wenzel of the National Aeronautics and Space Administration (NASA), developed the Virtual Interface Environment Workstation (VIEW), "a multisensory, interactive display environment" which enabled the user to "virtually explore a 360—degree synthesized or remotely sensed environment and ... viscerally interact with its components" (Fisher et al. 1988). Developed at NASA, VIEW was a user-controlled head-mounted, stereoscopic display system, predating the virtual recreation of the real for research and commercial applications (such as flight simulators) in the 1990s, providing a liminal space bridging the real and the unreal. This in turn led to both the adoption of virtual reality by artists and audience, and the bespoke and artistic creation of new and online spaces allowing for creation and exploration. The 1990s and 2000s saw a move towards software and hardware which enabled new forms of immersion, including the *CAVE Automatic Visual Environment*, a room sized immersive display. To access and engage with virtual worlds, the audience was required to navigate the space using headsets or controllers – creating a distance between the audience and artwork.

While some composers and artists utilised existing commercial platforms (such as Pauline Oliveros's work in *Second Life, see next page*), others pushed technology in new directions to inform their own practice, and develop innovative methods and scenarios to engage and immerse their audience – for example Char Davies, who uses virtual reality as a means to juxtapose the natural with the artificial experience, arguing the case of art as psychological experience. Of her own work, *Osmose* (1995), Davies notes that, "[i]n virtual reality, the interface is key to the media artwork and defines the character of interaction and perception" (Grau, 2003). This leads to the effect of "embodied presence" which, "in the course of the "immersion", results in an emotional state of being that is heightened still further by the music" (Ibid.). Davies' work suggests that by enabling an immersant to inhabit an alternative, computer-generated, unreal space, psychological effects can include experiencing changing sensations of time. The immersant is thus required to experience the virtual space as if it were an actual physical space, with engagement encouraged through familiar bodily functions to create a sense of embodiment within the constructed space, avoiding potential issues with detachment.

The "explosion of creativity and critical thought" of New Media art became a worldwide movement which "facilitated the formation of communities without regard for geography" from its inception, distributed through mailing lists and the internet, and reflecting the "increasingly global nature of the art world" marked by international biennials (Tribe and Reese, 2006). Collaboration increasingly involved networked collectives, for example Knowbiotic Research's *Dialogue with the Knowbiotic South* (DWTKS) (1994-1997) which used data from research stations to "create [an interactive] changing abstract representation of Antartica", which allowed the user "to 'immerse' himself into each knowbot" (Grau 2003, Archive of Digital Art, n.d. b).

Similarly virtual spaces provided experimental platforms for composers seeking to create new and innovative works, for example Oliveros – renowned for pioneering Deep Listening, her work utilised material properties of physical space and embraced the potential of the virtual for performance and collaboration and relates closely to the concept of the expanded narrative, through the listening experience (for both performer and audience) and the use of venue. Oliveros's collaboration with the Avatar Orchestra Metaverse within *Second Life* began shortly after the group's formation in 2007, using her avatar 'Free Noyes'. For the premiere of *The Heart of Tones* (2008) (created by Oliveros as a recreation of the 1999 work of the same name) which took place simultaneously at the Open Space Voice+++ festival in Victoria, British Columbia, and 'in-world', Oliveros co-developed a 'virtual instrument' with Andreas Müller, for the avatars of the Orchestra to wear, which "include[d] individual controls for volume, duration, frequency and colour spectrum", together with customised avatar animations "designed to provide subtle variations [sic] and evolutions in the perception of the received sound" (Avatar Orchestra Metaverse 2017). Oliveros was involved with two further works with the Avatar Orchestra Metaverse: a networked collaboration with Stelarc titled *Rotating Brains / Beating Heart* (2010) and *Vancouver Calling* (2012), composed for the 2012 Canadian New Music Forum.

3.1 The audience within the virtual space

The adoption of technology contributes to the creation of an expanded narrative where the audience is involved in creating their own experience of a work. The digitally constructed virtual space builds on this, allowing for new affordances for composers and artists who embrace these spaces to construct new experiences and performances for their audiences, enabling new forms of interactivity, where, according to Elizabeth K. Menon (2007), the action is shaped by the collaboration between the artwork and user, leading to the potential of different experiences with each encounter.

The audience is thus able to experience a hybrid space between the physical and the virtual by means of computer peripherals such as a mouse or keyboard, sensors, or in the case of the virtual environment *Second Life*, through an avatar, as represented by a Venn diagram where the physical and the digital exist independently (see Figure 1). Virtual works exist somewhere between both realms, allowing for experimentation and alternative forms of practice. The interface (for example a browser/keyboard/mouse used to access *Second Life*) therefore acts as a portal, allowing the audience to explore a constructed, digital space. These virtual spaces allow the creator to be in complete control of the location and staging of a work.

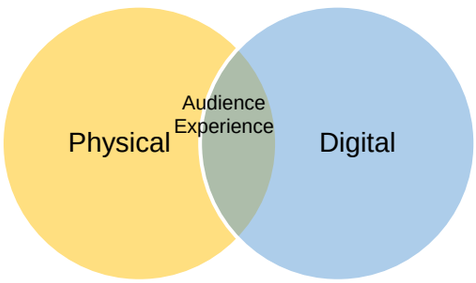

***Figure 1**: Venn diagram representing the audience experience as linking the physical and digital*

Live theatre and art had incorporated audience involvement for some time, for example improvisation (responding to suggestions from the audience), happenings and the *FOOD* restaurant which opened in 1971, created by Gordon Matta-Clark, Carol Goodden and Tina Girouard). As Janet Murray (2017) notes, the attraction of this lay "in inviting the audience onto the stage, into the realm of illusion", into what she describes as "holodeck experiences without the machinery", which blur the boundary between artwork and audience. Towards the end of the century, advances in technology further enabled the creation of immersive experiences to be completed by the presence of the audience, for example *Divina Commedia: Praxis for Death* (1991) which was created by Masayuki Towata and Yasuaki Matsumoto, as a "completely bodily immersive installation", inspired by float tanks and near-death experiences, in which visitors could float within a pool of edible gel, lit by a sequence of light patterns.

4. THE GAMIFICATION OF ARTS AND CULTURE

The means of communication and interaction as opened up by cyberspace and digital technology enable new forms of creation and participation. The growth in the development and adoption of online platforms – both for culture, and for work, can also be seen in the use of web-communication tools including *Microsoft Teams* and *Zoom* for meetings, collaboration, and events.

Replacing face to face communication with an embodied virtual (and remote) online presence requires the use and movement of an avatar within a 3D environment – such as that presented by Second Life and Gather. Town, the web-conferencing software launched in May 2020, which through it's top-down view of a virtual room, navigated using the arrow keys, calls to mind action-adventure games such as The Legend of Zelda (1986-). Exploration and interaction within these virtual spaces draw parallels with open world games such as Ubisoft's *Assassin's Creed* series of games (2007-). The gameplay in early instalments (for example *Unity* (2014) and *Syndicate* (2015)) places the player at the centre of the narrative, as an 'initiate' in a fictional organisation accessing the memories of the protagonists they then control throughout the game. The camera angle shows a third person viewpoint, from an angle behind the character, however connection between the player and the character is ensured through free movement, making tactical decisions on gameplay and the ability to have exercise some control over the choice of clothing and weapons. The concept of world building through open world computer-based spaces and games is shown through the success of games such as *Second Life* and *Minecraft*, which continue to be active spaces for audiences and creatives. Both spaces have been embraced by artists – Blockworks is a global studio of creatives working within *Minecraft*, while *Second Life* is home to large numbers of galleries, exhibits and performances. Other online user created spaces include *Roblox* (2006-date), through which users can create their own games and experienced to be accessed by others.

The movement towards innovative online spaces (and the need for telematic, yet engaging experiences as a result of the pandemic) suggests a move towards 'gamification' within culture – drawing

parallels between the ways that computer games and screen-based experiences engage (and arguably immerse) the audience, and the manner of engaging with the former (though a keyboard/controller and screen) lead subconsciously to a learned manner of using such techniques to navigate and activate the latter. This play-based interaction calls to mind Roy Ascott's concept of behaviourist art works which require game-like participation from an audience, and the navigation of Jeffrey Shaw's *Narrative Landscape* (1985) and *Legible City* (1989) which utilise a joystick and bicycle respectively. Composers and musicians who have embraced technology in the creation of engaging and immersive digital experiences include apps featuring the work of Björk, Steve Reich and Radiohead. Both Björk's *Biophilia* (2011) and Universal Everything's *Polyfauna* (2014) – created with Radiohead) allow the audience to explore immersive, audio-visual, digital environments, while *Steve Reich's Clapping Music* (2015) allows users to perform this work for themselves.

5. REACHING NEW AND DISTANT AUDIENCES IN TIMES OF CRISIS

Global pandemics, lock downs and social distancing saw a return to innovative and remote digital experiences. While it was no longer possible to have physically engaging experiences, digitally augmented technology experienced a resurgence, perhaps becoming even more essential than at the turn of the century. Workplace chats and social gatherings were replaced with telematic connections – hugs and visiting being reduced to pixels on a screen. Games were played over skype, Christmas parties took place through shared screens, and online workspaces like Zoom and Microsoft Teams replaced work-based collaboration. It should also be noted that the current generation of school children (both at primary and secondary levels) are growing up in the parallel spaces of the real and the virtual, in both their educational and social lives. While not necessarily the first generation to do this (the Alice Springs School of the Air in Australia, for example, has been operating via two-way radio since the 1950s), the presence of COVID led to the necessity to ensure the continuation of learning through lockdowns and self-isolation.

In November 2020, Innovate UK published a blog post reflecting on the *BEYOND* conference (on creative research and business innovation, November – December 2020) and on the cultural impact of COVID-19 (Smith 2020). In the same month, the International Council of Museums suggested that 6.1 percent of museums had closed globally as a result of the pandemic (Ings 2021). Innovate UK's post noted that the timing of the pandemic occurred at a peak time for immersive, virtual technologies which allowed for hybrid experiences, and thus the potential for innovation in the creation of engaging, yet safe, performances. The *BEYOND* conference itself examined how audience experience has been affected by the pandemic and the creative responses that aim to address the widening gap between culture and audiences, recognising that screens have become our windows on the outside world. A poll of attendees considered the impact of lockdown on audience engagement and found that audiences were missing being part of a collective experience, and that a defining cultural outcome of the pandemic is the widening use of digital technology for live performance and distribution.

While prior to COVID-19, heritage attractions and educational institutions, such as Blarney Castle, the United States Holocaust Memorial Museum and North Carolina State University had extended their physical footprint into virtual space using Second Life in order to reach wider audience and showcase how the space was being used to enhance their activities; still others responded to the pandemic by allowing virtual visitors to explore their exhibits, including The Peale in Baltimore, whose digital representation replicates the original building and hosts exhibitions, tours and events and allowed virtual visitors to explore the museum and attend events from their own homes as avatars, using a viewer available for both Windows and Mac operating systems. In this way both equipment and techniques associated with PC gaming are shown to be adopted for wider cultural and artistic purposes, particularly as necessitated by social distancing and lockdowns.

Access issues created by the COVID-19 pandemic naturally led to further overlap between technology and heritage. In 2021, the Natural History Museum (NHM) in London has thirteen opportunities for visitors to engage with their exhibits from home – including a virtual tour of the *Fantastic Beasts* exhibition, an interactive exploration into the life of a blue whale, and interactive talks with scientists. Worldwide, galleries responded to the pandemic by providing online content: Art Basel created online viewing rooms, while the *Frieze* art fair was held virtually in 2020, and the Lisson Gallery collaborated with Augment to provide digital content that could be placed in the viewers own home using augmented technology. In August 2021, the Falko Alexander Gallery in Cologne both recreated its gallery, and created exclusively virtually accessible content, which enabled the venue to both extend the reach of its physical exhibitions and provide a temporary archive of the digital versions.

By bridging "analogue" physical and digital worlds, access issues created by the pandemic can

potentially be addressed, specifically through the use of Augmented Reality (AR) and VR (using mobile phone-based apps, which are relatively cheap, easy to access and use, or headsets which are equally becoming more affordable. AR was used to create innovative application (or app) based experiences, including those for The National Trust, firstly to reveal to visitors the potential damage of climate change to its properties (2019); and to encourage more families to visit sites (such as *The Playful Garden* (2020) in which a 3D version of Brodie Castle's famous rabbit sculpture, Brodie, was brought to life). While both these examples require audiences to be physically present within the venues, a similar use of technology bridges analogue and digital worlds by allowing the user to view and interact with historic artefacts within their own home, for example the BBC Civilisations AR app (2018) which was developed as a pilot companion to the series of the same name.

By continuing to place the audience at the centre of the work, yet changing where and when that work takes place, consciousness and engagement replaces the physical, and keyboard and mouse interactions take the place of bodily engagement, leading to a new era of immersive possibilities.

As the obverse to this almost utopian viewpoint of an online digital society, and to provide balance, it is relevant to consider that while there are many positive aspects of digitally augmented online experiences (for example, travelling through time and space to other locations and historical periods, and reducing emissions related to travel for work and leisure), not all outcomes of our increasingly online society are positive. While access to mobile digital technologies has the potential to enrich and enhance everyday life, it also redefines concepts of privacy and personal identity by also subjecting users to control and surveillance – including cookies tracing movement across the internet, and the collection of personal details (for example the Cambridge Analytica scandal in the 2010s in which millions of Facebook customers had their data collected and used for advertising without their consent).

Such technology (and the companies behind them) operate on a system which places value on our interactions and activity, using this data to personalise advertisements, and to populate the material content of the services. Additionally, attention to (and obsession for) screen-based technologies – such as social media, email, games and streaming services – has the potential to overstrain and exploit our perceptive capacities, thus affecting well-being though issues as sleep disorders. In this way, while making communication and interaction possible, such technology arguably alienates us from human interaction – for example the 'troll' or 'keyboard warrior', hiding behind anonymity to share misinformation or hateful material. It is therefore necessary to educate and arm ourselves with the skills and technology necessary to both keep our information secure and to have the safest experiences online.

6. CONCLUSIONS

The three factors of active space, collaboration, and active audience together form an expanded narrative. Digital technology has both allowed for new forms of immersive practice, and new spaces in which to create, perform, collaborate and experience. The need to create ever more immersive (and thus productive) integration and engagement of remote participants is exemplified by the recreation of Facebook as Meta in 2021 – incorporating a range of VR and AR technologies to enable connection and exploration for immersive learning, innovation, connection and exploration within the metaverse.

The growth of online platforms has enabled global access to methods of engaging with or creating material. Examples of such include: films (from Youtube and Vimeo to Netflix and Amazon), art (from creating an artist portfolio using one of the many web creation tools available, to online content from the Tate and the Royal Academy), and music (from Soundcloud to Spotify and Amazon Music). Similarly, it has allowed for online and remote learning for pupils and students of all ages in response to the growing requirement for social distancing and lockdowns in response to the current global pandemic.

It is both testament to the continued relevance of immersive technologies, and a fitting conclusion, that in a twist of fate our once communal, social experiences are replaced by shared, yet disparate spaces – online gaming in place of arcades, social media in place of clubs and societies, and video conferencing technology used for conversation and collaboration. As the obverse to the 'architectures of the post-anthropocene' as described by Liam Young, where significant contemporary spaces (such as warehouses, ports and data centres) are now devoid of inhabitants, our digital selves now go where our physical bodies cannot. In this way, we have become part of the machine, our cells and atoms becoming bytes and pixels, allowing us to exist beyond our geographical and physical limitations to participate in the arts, culture and other experiences which have led on from these innovations.

Virtual Reality content such as games, software and social spaces are now readily accessible to domestic audiences using Valve Index, HTC Vive,

Oculus Rift, Windows Mixed Reality, and other headsets, through online marketplaces such as Steam. Similarly, *Zwift* is an online cycling and running program which allows users to pair their equipment with the software to train and race against others within a virtual world.

New forms of experiential art and performative spaces have developed as we learn to live within a 'new normal', leading to new interactions between humans and technology. While a virtual visit cannot replicate a physical one – there is much to be said for actually visiting a tangible space and immersing oneself in the sounds, scents and material properties of a castle, gallery or museum – a virtual, online visit has its own benefits: for one it is cheaper, and safer, and for another, it can take place at a convenient time, and from the comfort of our own homes.

Through the creation, and the enhancement of existing, digital provision, cultural and heritage venues would be able to remain open and viable throughout the pandemic and beyond – while also providing the public with access to methods of understanding and engaging with venues and sites which they may be unable to visit in person. Similarly, through the virtual experience of art works, museum collections and information on areas of historical interest, a potential lifeline could be extended to those organisations that have been forced to close or drastically alter their provision because of measures brought in to limit the effects of the pandemic.

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Monument Public Address System AR

Meredith Drum
Virginia Tech
203 Draper Rd., Blacksburg, Virginia,
USA 24061
mdrum@vt.edu

Figure 1: *Monument Public Address System AR, documentation 1, 2022, Meredith Drum, animation and augmented reality.*

1. INTRODUCTION

Monument Public Address System AR is a multi-platform interactive documentary project centred around a growing collection of audio interviews about the past, present, and future of confederate and colonial monuments. Formally and technically the project is a place-based augmented reality app accessible on a participant's mobile device. The goal of the project is to engender critical and thoughtful social experiences in public spaces through the presentation of narratives that offer truth and justice-centred perspectives and anti-racist visions for our shared future.

2. MONUMENT PUBLIC ADDRESS SYSTEM AR

Monument Public Address System AR is a digital media documentary revolving around an expanding collection of audio interviews about the past, present, and future of confederate and colonial monuments across the United States. The interviewees include activists, scholars, students, planners, community organisers, and other artists. Some have discussed feelings of anger and exclusion when they encounter confederate and colonial imagery. Others have evaluated the symbolic violence of the monuments in relation to ongoing racist systems, and/or described potential liberatory sculptural works as replacements. Their generous narratives enable the project's main goal: to engender critical and thoughtful experiences in public spaces.

The AR app invites participants to open *Monument Public Address System AR* on their mobile device to discover 3D virtual objects and animations superimposed on the world around them. When they interact with these objects, short sections of the audio interviews are triggered and play. As they listen to the narratives, participants can explore the virtual animations in relation to the surrounding physical space (Figures 1 & 2).

The app is designed to be as accessible as possible. While the augmentations are geo-located, and the intention is for participants to circumnavigate confederate and colonial monuments – and the empty spaces where they once stood – when experiencing the AR, the app can be opened anywhere. Moreover, the app is mobile AR, which can be used on a large variety of hand-held devices and is not dependant on expensive technology.

2.1 Digital placemaking and AR

The project is situated within a growing body of research regarding digital place-making. The production has been inspired by other practice-based research initiatives that share the goal of facilitating positive social change while employing emerging mobile technologies to investigate real-world civic challenges. Two exemplary artists within this realm are John Craig Freeman, including his 2-16 *Wuhan Wet Market*, (Freeman 2016) and Teri Rueb and her 2017 *Fens.*

2.2 Monuments and social impact

Concurrent with reading about placemaking and augmented reality, this project is also inspired by scholarship regarding the social impact of monuments. The interviewee's narratives align with much existing writing about racism and confederate and colonial monuments. Ana Lucia Araujo, historian and professor at Howard University, writes:

> When black and brown people open a textbook, visit a museum, or look at the statues displayed in major squares of the main European and American capitals, they only see images of white men, who were wealthy, who had power and who very often were slave owners or slave traders. Then when black men women, and children are challenging proslavery statues, they are denouncing this past that remains alive in the present. . . . All monuments emerge and disappear because of political battles that take place in the public arena. Likewise, public memory is always political (Lucia Araujo 2020).

3. CONCLUSION

Monument Public Address System AR is offered as a platform for visual and aural expressions of frustration, anger, sadness, fear, and confusion regarding the racist, unjust and violent narratives that have shaped and continue to shape our present and future. It is also built for the enunciation of anti-racist hopes, activities and initiatives. As a cis-gendered middle-class white woman from the United States, the producer of this project, Meredith Drum, recognises that her position and perspective regarding the racist history carried by these monuments is limited. She has initiated the project as a way of discovering, and unpacking her blindspots. She sets out to support critical thinking about the future of public monuments in the United States.

For more information: https://vimeo.com/648323257

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***Figure 2**: Monument Public Address System AR, documentation 2, 2022, Meredith Drum, animation and augmented reality.*

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Storytelling and VR: Inducing emotions through AI characters

Gabriela Maria Pyjas
University of Greenwich
London, UK
gabriela.pyjas@gmail.com

Jonathan Weinel
University of Greenwich
London, UK
J.R.Weinel@greenwich.ac.uk

Martyn Broadhead
University of Greenwich
London, UK
M.P.Broadhead@greenwich.ac.uk

Recent forms of virtual reality (VR) have changed the way people interact with moving images in the entertainment and the games industry, as well as the way the content is created. Technological advances in VR have given an opportunity to create simulated environments that users can immerse themselves in, and sense almost as a real experience by combining film techniques and interactive media approaches. Storytelling in VR presents various challenges due to the spatial properties of the medium. Research suggests that engaging Non-Player Characters (NPCs) enhance storytelling and can do so by communicating emotions. Most VR war experiences use the concept of morale and emotions applied to a group of soldiers or individual characters. To address the need for more believable AI characters in VR, this project will investigate how emotions can be communicated more effectively in a VR war application. VR companies are increasingly using Artificial Intelligence (AI) and cloud technologies to develop a stronger ecosystem for NPCs. However, there are still significant number of limitations in terms of technology and immersive storytelling for VR with characters and props paying significant role for creating convincing VR experiences. This project will therefore aim to enhance storytelling in VR by inducing emotions through AI characters in a war environment inspired by realistic events from WWII.

VR. Storytelling. AI. Emotions. Immersion. Affective computing.

1. INTRODUCTION

The term of virtual reality (VR) was firstly used in the 1980s by Jaron Lanier and can be defined in a variety of ways from painterly illusions to a three-dimensional experience with usage of the head-mounted display (HMDs) (Bucher 2018, p.3). VR's development has experienced peaks and troughs. The medium is still in its infancy, but after Facebook (now Meta) bought Oculus in 2019, VR has stepped in into the mainstream and brought the technology into people's homes (Bucher 2018, p.1). VR has become widely used in cinematography as well as the games industry.

The cinematic approach with a linear narrative concept does not utilise the full potential of VR, and instead the approach often used in games lets users discover the story. This has started discussions around storytelling for this media and how to create an immersive experience for the audience (Bucher 2018, p.6). Interactivity makes the biggest difference between VR and other storytelling mediums, due to spatial aspects (it is a three-dimensional, stereoscopic experience) and the ability for users to make decisions. Audiences can make decisions of where to look or how to interact with the environment and characters, which may have an impact on the narrative. Another major advantage of VR technology is that it can make the audience feel emotions (Ward 2017).

In order for storytelling in VR to be convincing, the non-player characters (NPCs) must also be believable. One of the ways this can be achieved is through a more accurate representation of human emotions. For war games, it may be possible to utilise concepts of morale and emotional reactions applied to an individual character or a group of soldiers (Mozgovoy & Umarov 2012, p.21–22).

This project will investigate the implementation of an AI character which can exhibit emotions in an interactive VR war experience. The war environment will provide a basis to explore the emotions of NPCs in combat situations, and investigate how these can enhance immersive storytelling in VR. This paper will discuss the background and context for this project through a discussion of VR storytelling, emotion in games, and AI in VR. Following this, this paper will outline the proposed project.

2. VR AND STORYTELLING

Storytelling for VR has led to two dominant philosophical trends and perspectives in VR. The first of these focuses on viewers as the passive observants of the action and surroundings. The second approach allows the viewer to become the camera and interact with the environment. Stories created in the latter way begin to blur the line with games (Bucher 2018). Storytelling in VR should be less about telling the viewer a story and more about letting them discover it. Viewers dropped into VR worlds should have freedom to interact on their own. The capability of provoking emotion together with interactivity makes VR a powerful tool to create an immersive experience (Ward 2017).

Immersion can be understood as a process of engagement for users that relates to various aspects of involvement including emotions. This process is described in Calleja's player involvement model, which identifies six dimensions of involvement in digital games (Calleja, 2001). Emotional immersion is a type of involvement and dimension of immersion when the player feels emotionally aroused by the narrative elements of the game. Enhancing emotions may provide a way to improve immersion for VR storytelling.

3. EMOTIONS IN GAMES

The key theory of emotion in psychology and neuroscience research states that humans have a limited set of basic emotions such as fear, sadness, anger, happiness, and disgust (Ekman 1999). According to the theory of basic emotions, each specific emotion maps to one neural system. However, the circumplex model of affect proposed by Russell (1980) can be integrated and summarised as a two-dimensional space defined by valence (pleasant/unpleasant) and arousal (activated/disactivated) axes.

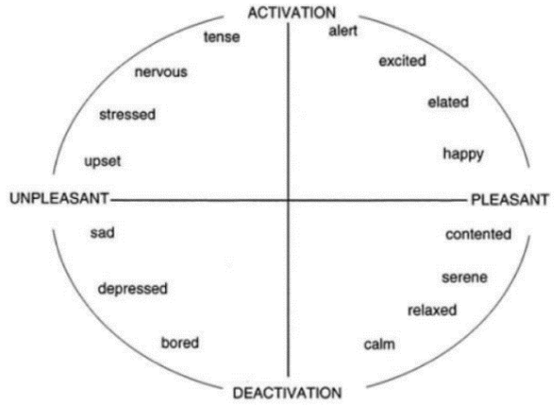


Figure 1: *Russell's (1980) circumplex model of affect.*

Game designers usually explore and test a wide range of mechanics that yield emotional states they desire to trigger into the player. Emotional states such as engagement, fear, stress, frustration, and anticipation can dependent on the genre, the narrative and the objectives of the game (Yannakakis & Paiva 2014).

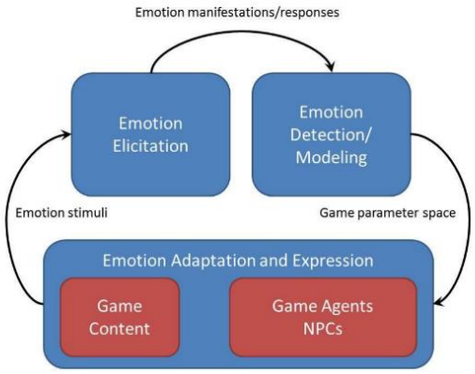


Figure 2: *Yannakakis and Paiva's (2014) realisation of the affective loop in games.*

Moreover, emotions can provide information to guide decision making. This idea is discussed by Damasio (1996), who stated that emotions are information providers and somatic markers represent by the gut feelings through a bodily feedback, which guides decision making.

4. AI AND EMOTIONS

Non-Player Characters (NPCs) may have a key role in enhancing emotional immersion. The most realistic NPCs in games are based on human emotions (Mozgovoy & Umarov 2012, p.2). This concept may be used in fighting and war games, to provide realistic human-like behaviours and indicate concepts or morale. If a war simulation can implement behaviours indicated by emotions in NPCs, and generate social interactions between them, and with the player, they may appear more believable. At the same time, this will improve immersion of the player into the combat simulation (Mozgovoy & Umarov 2012, p.21–22). Emotional states of NPCs should respond to current events and reflect changes in action in real time (Mozgovoy & Umarov 2012, p.23).

Research into the use of emotions in agent-based systems is mainly concerned with how to convey the emotions of NPCs to the player (Campisi & Caudell 2010). However, further improvements can be made by developing more sophisticated approaches through which NPCs can incorporate emotions in terms of their functioning through aspects such as decision making. This can be accomplished by drawing on approaches from the

field of affective computing (Picard 1997), which provides ways in which computer systems can recognise, exhibit, or respond to human emotions.

5. MODELING AI BEHAVIOUR IN VR

Modelling realistic human behaviour, including decision-making and creativity is a complex challenge for games developers, and this also applies in VR. Behaviour trees (BTs) are a relatively new technique for developing behaviour models for AI characters. For a long time, finite state machines (FSMs) have been the dominant technique in game AI, but a major strength of BTs compared to FSMs is their modularity and ability to yield complex behaviours composed of simple tasks. The main difference between BTs and FSMs is that they are composed of behaviours rather than states. BTs employs a tree structure with a root node and a number of parent and corresponding child nodes representing behaviours (Yannakakis & Tolegius 2016).

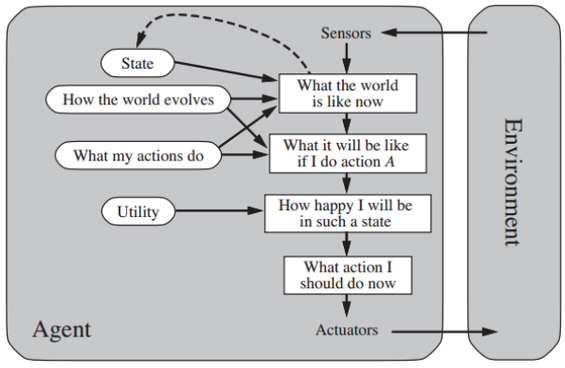
The strongest trend in current VR research is adding believability to virtual agents (physical and behavioural). This is sought in adventure games, as well as serious VR games. Also, AI characters are frequently utilised as intelligent tutors (Michalski, Szpak, Saredakis, Ross, Billinghurst & Loetscher 2019). For example, *Agence* (Transitional Forms 2020) is an immersive VR experience that combines cinematic storytelling, AI and player interactions to tell a story about little characters that inhabit a floating planet. Each character has a mind of its own, developed with AI learning systems. Agents can express fear, curiosity, boredom, or excitement using vocalizations and facial reactions. Another VR experience, *Medal of Honor: Above and Beyond* (Electronic Arts 2020) allows to step into the boots of an agent of the Office of Strategic Services (OSS) fighting through the biggest and most historic events of World War II. AI characters encourage the player into the gameplay as enemies or group of soldiers.

Another example that uses AI to build believable characters is *IMMERSE* (Playabl Studios 2012). It is a gestural based, virtual training simulation for soldiers using AI techniques to teach social skills in non-English speaking environments, developed in Unity. AI presents the basic human dynamics skills that soldiers need to understand to enter into any social encounter regardless of the culture, group, or situation.

6. PROPOSED SOLUTION

The project will result in the development of a final prototype which implements the AI character in a vertical slice of virtual war scenario with usage of Unity game engine for Oculus Quest 2 platform.

An AI character will be developed as part of this project, based on utility-based techniques, so the agent acts based not only on what the goal is, but the best way to reach that goal (Figure 1). Each action will be evaluated separately, and the highest scoring action will be chosen. The Utility AI can be used as a Behaviour Tree and implement its branch structure (Rasmussen 2016). For example, the AI character will start interacting with the player while he passes a certain distance.



Action	Scorer	Score
Move to Enemy	Distance to Enemy	0-100
	Gun is not loaded	-100
Fire at Enemy	Proximity to Enemy < 50	75
	Cannot make it to cover	50
	Gun is not loaded	-125

Figure 3: *An example of utility based AI structure.*

To implement a complex behaviour system based on utility-based techniques for AI characters will be used Panda BT Free. This is a script-based Behaviour Tree engine that allows creating complex, scalable and reusable logics for the game and it is compatible with Unity game engine (Figure 2). It eases up fast prototyping and iterative development (Begue 2019).

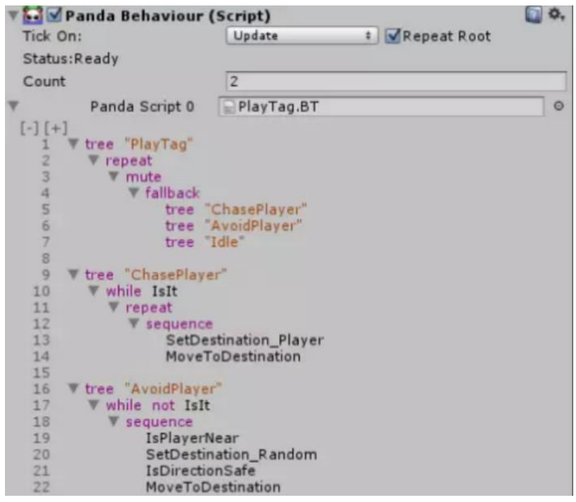


Figure 4: *A preview of Panda BT Free plugin. Character AI is defined via scripted branches of the behaviour tree.*

7. IMPLEMENTATION

The project is inspired by real events from The Dunkirk Evacuation (1940) during WWII called Operation Dynamo. The Royal Navy implemented evacuation of Allies troops cut off and surrounded by Nazi German troops from the beaches and harbour of Dunkirk.

Furthermore, the soldiers behaviours are inspired by memories of one of the soldiers, Harry Leigh-Dugmore, when German planes were bombing and machine gunning the beaches, he and his fellow soldier friends spread out as far as possible but then returned as nearly as they could to their position in the queue. He also brought down a Messerschmitt what been cheered as it crashed into the sea (Royal British Legion 2022). Inside the VR experience soldiers are also queuing on the beach and in the water. What is more, while bombarded by enemies they are attacking back or running away. Figure 5 is showing the model of AI BTs used in the final artefact. Each behaviour is composed of animations that illustrate current actions. Behaviours change after being successfully executed or regardless of action conditions.

Bombing is the initial event that leads to the next AI actions and emotional states (Figures 6 & 7). However, anger may increase while attacking, and fear while escaping. Successfully completed action may result in happiness. Utility AI techniques allow us to create an individual behavioural system based on the highest scoring action, which is also driven by current emotions.

Furthermore, the player functions (teleportation and interactions) are implemented with usage of XR Interaction Toolkit. The player has the freedom to choose the storyline of the narrative, and the way of interactions with the environment and characters. Due to this fact, the VR experience has a few possible storylines:

- Exploring without any interactions.
- Queuing with other soldiers.
- Taking part in actions together with befriended soldiers (escaping from bombing, shooting at attacking planes).

Figures 8 and 9 show screenshots from the VR prototype, illustrating key moments based on Harry Leigh-Dugmore's account. The AI characters respond to the situation, exhibiting emotional traits as they cheer a downed enemy aircraft (Figure 8), and queuing to board a boat (Figure 9).

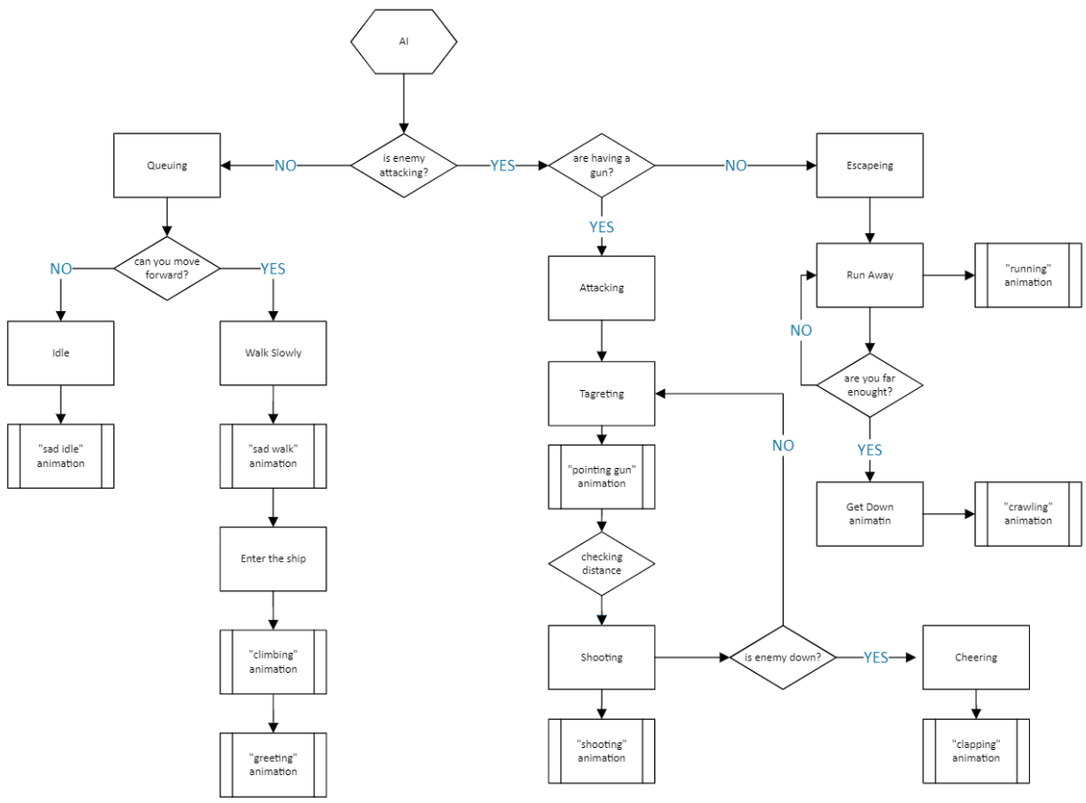


Figure 5. *A model of planned BT implementation in the VR experience.*

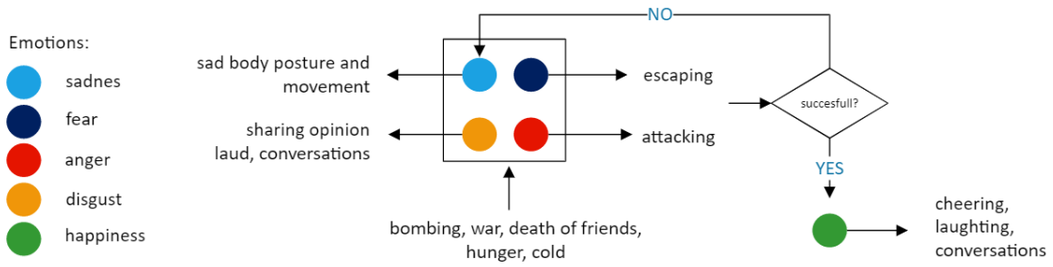


Figure 6. *The key factors of emotional states and its ways of expression.*

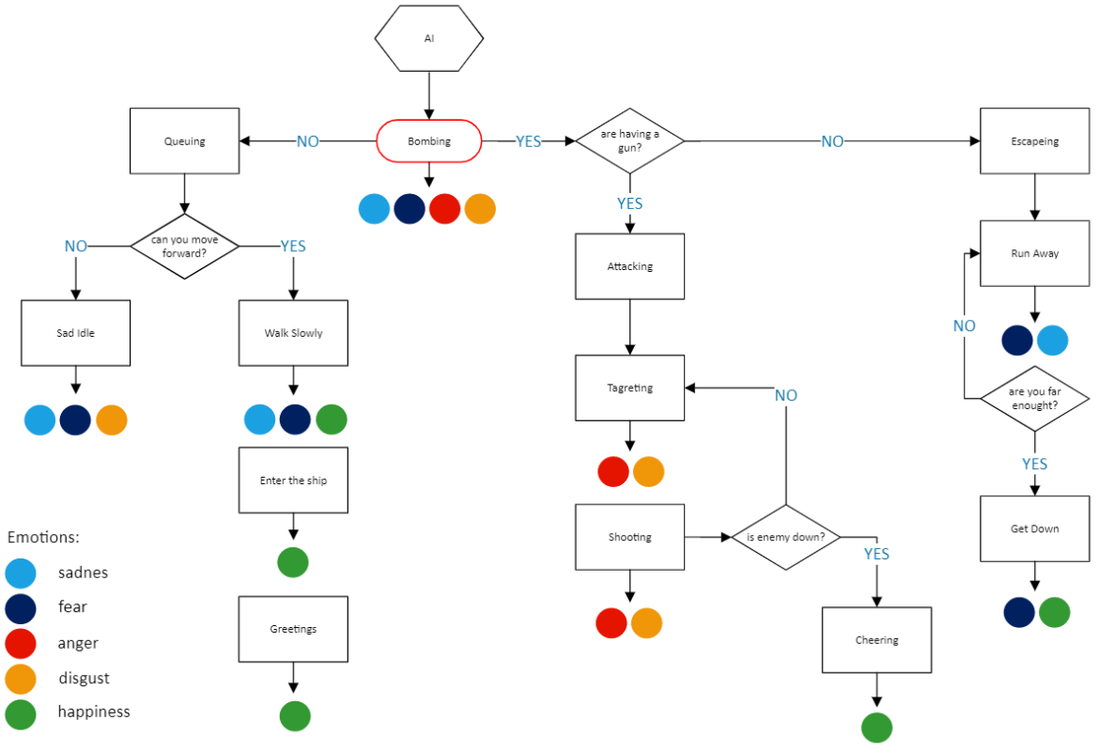


Figure 7. *A model of BTs with potential emotional states.*

Figure 8. *Screenshot from the VR prototype showing AI characters cheering as an enemy plane is shot down.*

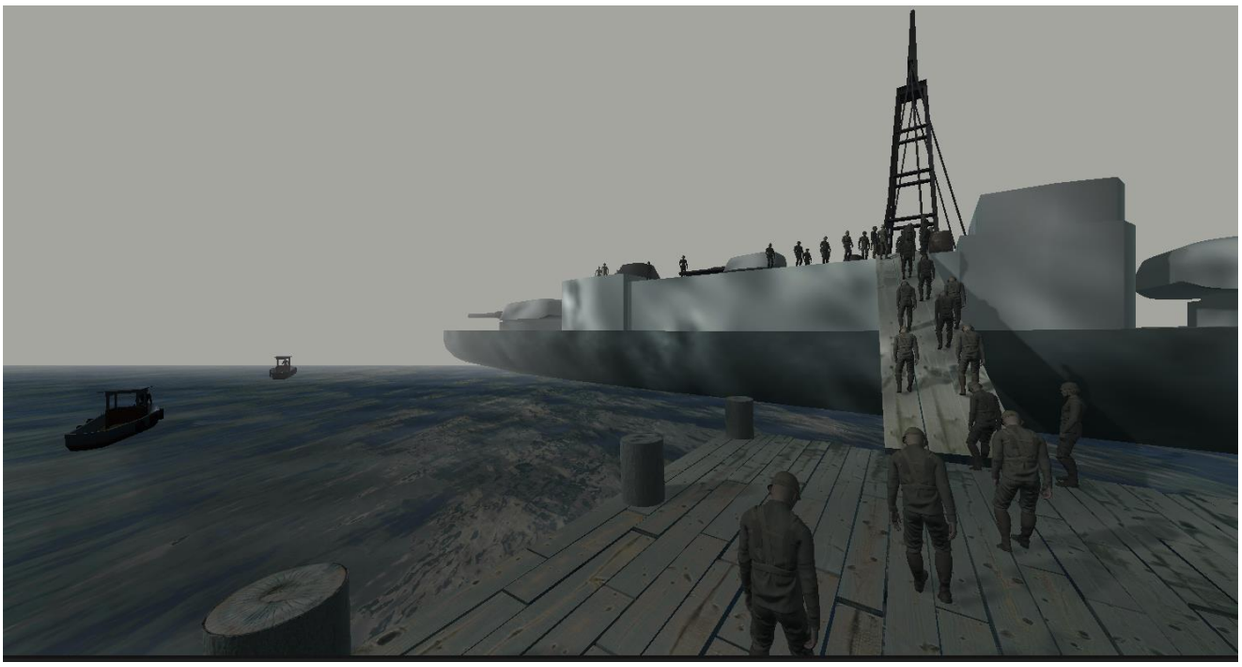


Figure 9. *Screenshot from the VR prototype showing AI characters queuing to board one of the boats.*

8. SUMMARY

Storytelling for war experiences have the potential to be very emotive for the audiences. Representing emotions through effective use of game characters should improve the immersion of VR experiences. To achieve this, AI characters should imitate human emotions. In our project, each NPC will have its own unique emotions and behaviours, which will be shaped by actual events. The usage of BTs and Utility AI techniques will allow us to create realistic emotional states and decision-making process of AI characters. Also, allowing the player freedom of interaction with the VR experience may provide better immersion, and help to create bonds with the AI characters.

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Eva Quantica VR

Maf'j Alvarez
Root Interactive
58b Davigdor Road,
Hove BN31RB, UK
mafj@rootinteractive.com

1. INTRODUCTION

I'm a digital artist, creative technologist and user experience designer based in Brighton, UK. This paper covers the unusual micro-commissioning process, creative constraints, design, creation, testing and distribution of making Eva Quantica – a VR experience for the Oculus (Meta) Quest headset created in 4 weeks and £4000 in a pandemic. Finally I will demo the VR experience.

2. THE RULES DO NOT APPLY

Eva Quantica VR is a dreamlike, painterly open world to explore Eve and her multiple selves. Along with proposals by Dennis Ogadabe and Fantasia Malware, I was selected from nearly 100 entries to an open call '*The Rules Do Not Apply*' by the National Gallery X, and Audience Labs at the Royal Opera House in March 2021, supported by King's College London. The commission asked for an artistic response to the painting '*Crivelli's Gardens*', by Paula Rego and the motion capture data of *'Eve*', choreographed by Kristen McNally.

The open call was unusual in that it invited applicants to download the motion capture files (IP) ahead of submission. Annette Mees of the Royal Opera house explained that it was the only way to evoke a truly interesting response. As an artist, it allowed me to embody ballet in VR – to stand next to and even inside the dancers and really 'feel' the movement. Also unusual was the generosity and curiosity of Kristen McNally who's choreography 'Eve' would be remixed. For me to have that freedom as a non-dancer was powerful. I proposed an open experiment in quantum futures for women through VR – one where all versions of Eve already existed, past present and future. A triptych of dimensions and perception. Viewers could choose to be a cat, human or statue.

The Paula Rego piece gave me the courage to ask about the role of woman within power structures, architecturally and culturally. My response to her work was in the encoding of the elements into the landscape and her permission to do 'outrageous things'. I was assisted in contextualising the piece by Priyesh Mistry, curator at the National Gallery. An essay by Gabrielle de la Puente was commissioned to go alongside the piece.

3. AGILE IN A BUBBLE

Despite working largely alone, I used an agile methodology. This allowed me to 'fail fast' and iterate often. I used the Miro online tool to create a canvas to organise myself with a mood board, flow charts and Kanban board with a set of experiments or 'spikes' that I would run for 2 weeks.

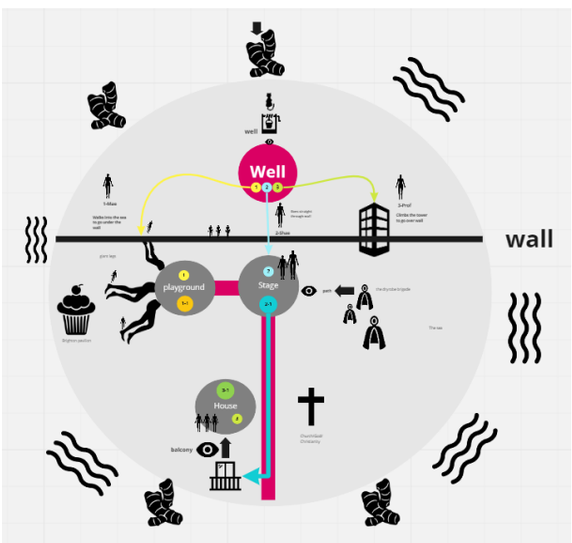

Figure 1: Section of Miro board – top view of bubble.

I had technical and creative constraints due to choosing the Quest headset. A high-end VR setup would have been expensive to show. Technical choices were to use Unity3d with URP and limited number of low-poly assets.

Working from The Fusebox, Brighton, I recorded daily streams of my working practice. This helped me to 'think aloud' and sound out my technical and artistic ideas to a future me. I put links on the Miro board and shared with the commissioning team. We met weekly to monitor progress. I sent Annette a Quest and she sideloaded files onto it for testing early builds. Kristen also received a headset but testing this way was not successful due to time and technical setup issues so we used video links and zoom calls instead. Creative technologist Andy Baker was my technical mentor during this time.

After the 2 weeks experimental phase, I evaluated and designed a new user experience flow through the piece. I moved towards a 'thin slice' of functionality to iron out major performance issues. I failed and restarted several times due to rendering incompatibilities. I committed changes frequently to a Github repository.

4 CREATING IN THE COMMONS

I chose to use free and creative commons assets, as the character skins for the motion capture would have taken a long time to craft and I wanted to celebrate the 'remixing' of digital assets. I wanted the piece to be rich with other people's contributions 'baked in'. I paid for a day of Unity Development support from Paul Hayes and a day of sound design by Anna Bertmark. Second release in 2022 will replace some audio tracks with music by Brighton based performer Bunty with whom I am collaborating in experimental VR music making.

I used free assets and rigging features of Adobe Mixamo and Sketchfab. Blender was used to modify models and combine meshes where needed for optimisation. I chose a simple aesthetic style with a limited encoded material palette. Rusty iron for dead or traditional ideas (from Rego) in the dried up well, statues, dead-bodies, trees in the park, boots in church. Emissive red was used extensively and a single tree mesh with roots and branches represented the 'life force' throughout. These objects were in the water like veins, as trees and roots, as menstrual blood in the bath and like lung alveoli. I chose to model the world on the one I experienced daily during Covid but modified through TV news reports and a warped perspective on the lives of others whom I saw on the screen remotely. A surrealist depiction.
I allowed the medium to guide my changes. Being able to work with the full spectrum of digital tools and with and enough developer experience meant I was nimble and could 'paint with my own brush' moving light and assets around where and how I wanted - testing in VR constantly.

5. AUDIENCE ENGAGEMENT

An online presentation evening was arranged by the National Gallery to present the projects. Afterward, I showed Eva in the street, the park, the pub, homes, a wild spa and campsite. I took the headset and a collapsible UVC sanitation box to as many places as possible. The piece has been very well received overall. I have shown it to over 100 people in person and has been installed for free to over 350 headsets via SideQuestVR.

It's worth noting that a headset screen can 'burn' if caught in direct sunlight. This is something to be mindful of. For me, the sensory benefit of outdoor VR is worth the risk. Finding adequate sunshade is the solution. Offering blankets in winter also helps. Each experience of the piece was 30 minutes long with 10 minutes taken up with introductions to the piece and controls. I had two headsets for 1 sanitation box.

In May 2022 the piece will have been shown in Brighton Festival main programme in up to 6 venues simultaneously on the same weekend. Each venue representing a different part of the Eva Quantica map. As I write, it hasn't happened yet but for you right now it may already be in the past.

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***Figure 2**: Eva Quantica VR – cropped section of screenshot from the experience. Maf'j Alvarez.*

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Augmented Symphony: An augmented reality application for immersive music listening

David Bouchard
Ryerson University
Canada
david.bouchard@ryerson.ca

Cintia Cristia
Ryerson University
Canada
ccristia@ryerson.ca

David Robert
Ryerson University
Canada
drobert@ryerson.ca

Michael Bergmann
Ryerson University
Canada
mfb@ryerson.ca

1. INTRODUCTION

Augmented Symphony is an augmented reality (AR) prototype that allows for an immersive music listening experience by introducing liveness through interactivity and visual engagement. An outcome of a Canadian research-creation project between Ryerson University and the National Arts Centre (NAC) Orchestra, funded by the Social Sciences and Humanities Research Council, Augmented Symphony provides an example of how orchestras can leverage remote delivery through AR technology to enable new ways for listeners to engage with a composition. The research team included a musicologist with expertise in inter-arts aesthetics, a visual designer specialized in performance, and a new media creative scholar, in fluent conversation with the Senior Director of Learning and Engagement at the NAC, the Managing Director of the NAC Orchestra and other personnel. Undergraduate and graduate students participated in a project whose goal was to explore ways of mitigating the impact of the reduction of live performances caused by the COVID-19 pandemic, both on orchestras and on their audience. Accompanying the app demonstration at EVA 2022, this short paper discusses the research, collaboration, and creative workshops that informed the design of the prototype and delineates opportunities for further development.

2. DEVELOPMENT PROCESS

The AR prototype was the creative outcome of a process that included quantitative and qualitative research, collaboration with stakeholders, and exploratory workshops. The initial stage of the project documented how orchestras connected with their audiences during the first year of the pandemic (Cristia et al. 2021). Two hundred and forty two initiatives implemented by a purposive sample of thirty-three orchestras in four continents were documented. These initiatives included concerts by the full ensemble or some of its members, in-person, live-streamed, and on-demand, as well as a variety of digital media. We looked at audio-visual integration and innovation. The data showed that, although most of the orchestral music was accompanied by a traditional "image track" reproducing the audience experience at a concert hall, a small number of initiatives explored innovative strategies to engage the audience. These included the integration of storytelling and animation, the addition of digital art, the recontextualization of musical works, and the use of GPS-based apps as an interface with listeners in an open-air setting (Buh 2021).

The second stage of the project consisted of discussions among researchers and stakeholders via two creative workshops. The first workshop, facilitated by the researchers via Zoom on April 27, 2021, included students from Ryerson University's Performance and New Media undergraduate programs, as well as graduate students from The Creative School. The students were presented with an overview of the NAC Orchestra, by their Managing Director, and the initial research questions and the collected data, by the principal investigator. Students were then asked to reflect about their own remote engagement with performances during the pandemic. Using Google Jamboard as an online whiteboard platform, they brainstormed on what would make them want to engage with orchestral performance remotely, considering format, interactivity, and diversity, among other aspects. Upon analysing the results of the workshop, four aspects emerged as the main opportunities of the experience: (1) audio spatialization, (2) re-imagining space, (3) content layers & overlays, and (4) community & shared space. The second workshop, on May 19, 2021, included the same students and musicians taking part in the NAC Professional Development Program. Participants were divided into groups and focused on brainstorming around one of the four areas mentioned above. As before, the results of

the discussions were shared back, and overall themes emerged. Audience agency and interaction, environmental storytelling, opportunities afforded by a virtual platform not possible in real-life, and supplementary material surrounding the performance were some of the important aspects to consider, according to this group.

As a final stage of the project, the research team synthesized the collected data, the analysis of the discussions, and the creative workshops in the design and development of a prototype AR application.

Figure 1: *The Augmented Symphony application*

3. PROTOTYPE FUNCTIONAL DESCRIPTION

Augmented Symphony leverages orchestral music and integrates the listener/user in the imaginary space of the orchestra. Users can distribute 'instruments' throughout their own environment, each playing the audio track of an individual instrument in the piece. Through this, users are able to create their own spatial mix of the piece which they can move through and explore. Instruments may be selected by centering them in the screen, which reveals the instrument name as well as exposing two options for users: a button that triggers a pop-up with further information on the instrument, as well as the option to delete the instrument. They may also be repositioned by tapping and dragging them on the screen. To further extend user experience and sonic comprehension, each instrument is represented by a pillar made of eight sections, taking the form of an eight-band audio spectrum analysis.

The application is built using Unity and takes advantage of its internal audio spatialization engine as well as the Oculus Audio Spatialization plugin to accentuate the effect. Considering the application was built for organisations staffed by assumed non-developers, details of the experience are altered through an online spreadsheet that is downloaded at runtime.

More detailed documentation of the prototype is available online at:
https://deadpixel.ca/projects/augmented-symphony/

4. FUTURE WORK

The application that we developed hints at alternative modalities that orchestras can explore to engage with audiences in a remote context. We have identified a few possible vectors for future work. First, we see the technology as a potential bridge between orchestras' ageing core audience and younger generations. Second, and perhaps most importantly, the affordances introduced by augmented reality enable the possibility of a visualisation layer to be added to a performance. We have hinted at this by modulating the shape of each sound source according to their frequency spectrum, but we believe that much more could be explored. For instance, an educational layer could provide listeners with a harmonic analysis of the performance, or a representation of how different instruments in the performance relate to each other musically.

Although spatializing individual audio tracks is not a new idea (related work include the collaboration between Mod Studio and the Australian Chamber Orchestra, for instance), apps like Augmented Symphony provide an immersive experience in a domestic setting, more in line with the social changes brought about by the pandemic and emphasize the perception of liveness by the users' interaction with the musical components.

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Through the Looking Glass to a Post-pandemic World, With New Media Artists as Our Guide

Terry Trickett
Trickett Associates
Barbican, UK
terrytrick@mac.com

This paper addresses the question: *In a post-pandemic world, what happens to culture: will our cultural institutions seize new opportunities for advancement or suffer decline?* New forms of digital aesthetics, which simulate works of art and cultural artefacts in their original settings, can now provide an immersive, interactive, computer-generated, experience of reality – an experience that not only matches people's growing expectations but, also, keeps abreast of the way proactive art galleries and museums are seeking to engage with the public. Art and technology offer a way forward as long as both elements are woven seamlessly together. In tackling this task, we can anticipate that new media artists will act as our guide in leading the way through the Looking Glass from reality to virtuality – a feat of artistic creativity that will enable our cultural institutions to emerge from near catastrophe to face the rigours of a new age. The City of London provides a test case of post-pandemic planning with culture joining commerce in a spirit of partnership and sociability.

New media art. Museums. Art galleries. Digital aesthetics, Extended reality. City of London.

1. INTRODUCTION

At a recent EVA (Electronic Visualisation and the Arts) International Session, held virtually in São Paulo (EVA-MINERVA 2021), participants expressed diverse views on the question: *In a post-pandemic world, what happens to Culture; will our Cultural Institutions seize new opportunities for advancement or suffer decline*? EVA, as a worldwide community embracing artists, curators, art historians, archivists, technologists, computer scientists *et al*, is remarkably well qualified to take an informed view on a subject which has leapt into the consciousness of our exhausted Covid-ridden minds. We have all felt the emptiness of an existence where, instead of visiting museums and art galleries, we see art 'on-screen' rather than in reality and experience the cultural artefacts of history as pale imitations in books rather than in actuality. Always, it is past experiences of the real that hold firm in our long-term memories – memories that fleetingly can be brought back to life by mind-jogging images on screen or the printed page.

What of a future where we might be denied any access to original, great works of past civilisations or, for that matter, contemporary creations when they are located in far-away continents? I don't think any of us can imagine a future where travelling a few thousand miles might present an insurmountable
barrier in fulfilling our need to feed our memories with life-enhancing experiences. But, for our grandchildren, that is the bleak, dystopian world that now beckons; for them, the question of whether or not it is possible to produce an acceptable digital immersive experience of reality becomes a subject of pressing concern. For those of us, too, who already possess a memory bank of experiences, the idea of being able to recapture them conveniently in close-by locations is tantalising.

Taking Culture as my starting point, I'm aiming to show how new and developing Immersive Technologies can contribute to the creation of a post-pandemic world that will enable us to see, hear and learn about works of art and cultural artefacts in virtual and augmented environments. As a process that represents a move from physicality towards digitality, it will not only enable museums and art galleries to survive and prosper but, also, impact on the way our cities adopt strategies for recovery by attracting people back for work and leisure. The City of London is one such case where culture is set to join commerce as a way of fuelling renewal.

In facilitating these instruments of change as we move towards a post-pandemic future, it can be anticipated that new media artists, working with technologists and architects, will play a crucial role.

2. THE SEARCH FOR NEW FORMS OF DIGITAL AESTHETICS

There was general agreement, at EVA São Paulo, that audiences for either screen-based or 3D and 4D simulations of works of art and artefacts, in their original settings, will always demand an enhanced digital version of what is real rather than a mere replica of what might be experienced during a gallery or museum visit. The search is on, therefore, to find new forms of digital aesthetics that will match people's expectations and, at the same time, keep abreast of the sweeping changes that are impacting on the way galleries and museums engage with the public. In his recent book, 'The Art Museum in Modern Times', Charles Saumarez Smith opines:

> In the aftermath of an international pandemic, people will value the experience of art, in whatever form it takes, more than before and will not take international travel and cultural tourism so much for granted. Galleries will reduce the number of exhibitions dependent on international travel not just for works of art but for curators as well; many have discovered new online ways of communication with their audiences during periods of closure (Saumarez Smith 2021).

It appears that the traditional perception of the gallery, as a 'cathedral of art', is under attack; it should no longer be focused entirely on the values of the past and history but, also, become a place of 21st century experiment:

> somewhere to think about the nature of art rather than to be told about it; somewhere for people to experience art, to look, to interpret and explore in accord with their own independent appetites.

2.1 Experiments at National Gallery X

Proactive galleries, even before the pandemic struck, were beginning to explore new ways of holding conversations with the public, telling stories, creating experiences and collaborating with other institutions. At National Gallery X (NGX), a joint project between the National Gallery, London, and King's College, London, the Almena Group of new media artists was invited to develop 'KIMA: Colour' – a project that started life as an in-gallery immersive light installation and then, after interruption by Covid-19, became a multi-sensory artwork that could be experienced by audiences at home. This transition was achieved by harnessing digital technologies currently used in the entertainment sector, and other experimental systems being developed by King's College, to simulate the presentation of art and artefacts in illusional settings (National Gallery X 2021).

At EVA Såo Paulo, Oliver Gingrich and Aphra Shemza presented a follow-up NGX experiment in transformative art, 'Art in Flux: Reclaimed' - a celebration of work by twelve innovative new media

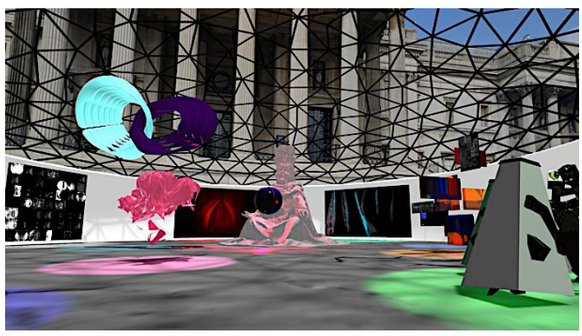

Figure 1: *Art in Flux Reclaimed virtual exhibition, featuring the work of Olive Gingrich & Shama Rahman, Aminder Virdee, Camille Baker, Kimatica, Ro Greengrass & Maddy James and Aphra Shemza & Stuart Batchelor. Image courtesy of Art in Flux.*

artists. Here, visitors to a virtual gallery located, notionally, in Trafalgar Square gain glimpses of the National Gallery, itself, through a virtual transparent roof which is eerily reminiscent of the British Museum's glazed courtyard (Figure 1). In this immersive setting, as a test of visitors' credulity and dexterity, they are required to engage with online works of new media art; each artwork requires visitors to navigate their own route through and round it. In other words, Art in Flux: Reclaimed provides an illusionary setting where dexterous fingers on a keyboard replace the physical steps of wandering feet on a hard gallery floor. (Art in Flux: Reclaimed 2021).

2.2 New media art as a platform for communication

Figure 2*: In 'INTER/her' by new media artist, Camille Baker, a 'Sitting Womb' provides visitors with a visual exploration of the female inner world. The 'real' version enables visitors to feel haptic sensations in the lower abdomen and hear stories related to female reproductive diseases. (Image courtesy of Camille Baker).*

All the separate exhibits in 'Art in Flux: Reclaimed' demand close investigation but, here, I'm choosing just one as an example. INTER/her is an intimate

immersive journey through the female body presented by new media artist Camille Baker. Working with a gynaecologist, Camille gives focus to female reproductive diseases, explored through a feminine lens, to raise greater public awareness of the inner world of women's bodies and the diseases they suffer. I've been taken on the INTER/her journey myself, in reality, with Camille as my guide. First, I was dressed with a haptic corset and then fitted with a VR headset before crawling through the vaginal style opening of an igloo shaped tent to enter a Sitting Womb. What then happens for participants, just three at any one time, is a free visual exploration of the female inner world with haptic sensations felt on the lower abdomen, all triggered by stories, events and objects heard and seen within the realm of VR (Figure 2) (INTER/her 2021).

My own full-on experience of INTER/her, when trapped within the confined physical reality of an igloo/womb, raises the question: Can any similarly palpable experience be gained by visitors coming across Camille's work in a virtual gallery? The answer has to be 'no', of course, but, through the operation of keyboard controls, a screen-bound visitor can gain a semblance of the journey in his or her mind's eye. In my opinion, this limitation does not negate the value of 'Art in Flux: Reclaimed' as a 21st century experiment in exploring new approaches to public engagement. As the National Gallery has recognised, it's through new forms of digital aesthetics that it can reach new audiences in remote locations, worldwide. The process becomes a two-way exchange of mutual benefit; new media artists gain new platforms of communication; museums of art find new ways of holding conversations with the public, which enable them to spread their sphere of cultural influence in local communities far and wide.

2.3 Boundless Worlds

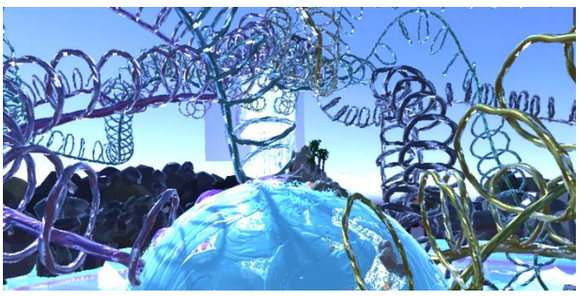

Figure 3: *'Odyssey: Ride' is Fion Gunn's own part in the worlds of Boundless. It's a roller coaster of images and sounds which enables visitors to change pathways, to hear a story or read a poem, all embedded in a virtual world. Image courtesy of Fion Gunn.*

I found that setting up the EVA São Paulo International Session, far from being an extended organisational process, was relatively easy. A number of invitees responded quickly and with enthusiasm to a suggestion that they should contribute to a debate of immediate interest to the worldwide EVA community. I've referred, so far, to Art in Flux, an artists' collective whose recent work at NGX and elsewhere has caused them to gaze long and hard through a Looking Glass into a foreseeable post-pandemic world. A-Maze artists, too, a group formed as a direct consequence of the pandemic, has taken a similar leap into the unknown (A-Maze Artists 2021). It seems that, far from keeping artists apart, the present crisis has shown how interconnected we all are in striving towards the realisation of virtual worlds through emerging digital tools and reaching out for audience participation. Fion Gunn, who initiated A-Maze artists in March 2020 presented, at EVA São Paulo, an ambitious digital project, 'Boundless: Worlds in Flux', where visitors experience the interconnected worlds of artists in an *'interactive prototype for our online multiverse'* (Boundless 2021). She says it's like dropping into a museum or public gallery.

For her own part in the virtual assembly of Boundless, Fion created 'Odyssey: Ride', supported by Tate Exchange Liverpool, to celebrate the exciting and positive aspects of change and flux (Figure 3). It's a complex and cyclical roller coaster of images and sounds which allows visitors to change pathways and make stops to hear a story, read a poem or watch a short film, all embedded in a virtual world (Odyssey: Ride 2021).

3. MUSEUMS AND GALLERIES AT THE CROSSROADS

In its aim to connect the virtual world with the real world, the work of A-Maze artists reflects a process of digital development that has gained momentum due to the pandemic; the rising digitality of our lock-down lives push us evermore towards virtual life. Tula Giannini, describes this transition as follows (Giannini & Bowen 2018):

> As the tension between physicality and digitality grows, the longer Covid-19 continues, the more human behaviour adapts to altered states of being digital while the public square, the place where people gather and socialise shrinks, we find ourselves in retreat from the life we knew as big tech and big government occupy the void.

Tula then poses the question:

> What will happen to the public places we abandoned during Covid-19, and what will motivate people to come back, and will museums be able to attract new audiences?

In her answer, she endorses the skills and motivation of new media artists, such as those who presented at EVA Såo Paulo:

> Enter digital artists, designers and museum curators – those who know how to use digital to make art and engage audiences, to tell stories and be contemporary and relevant. Digital artists, whose presence in museums seems sorely lacking must assume a more central role in digital integration and visualisation of human dignity and identity. Curators ……recognise the need to collaborate with artists as new narratives, which in turn open up museums to reimagine collections in ways that encourage them to engage with more diverse communities, artists and audiences.

The above quote is taken from 'Museums at the crossroads: between digitality, reality and Covid-19', a paper by Tula Giannini and Jonathan Bowen delivered at EVA London, July 2021. The authors extol artists' use of advanced technologies, including 360, VR, AR, and MR simulations, in anticipation of a post-pandemic world where all forms of new media art (including digital) are moving centre stage. Presenters at EVA São Paulo concurred in the view that, in the future that now beckons, we must be ready to tackle and control the unstoppable forces of digital revolution - a jump through the Looking Glass that will enable our Cultural Institutions to emerge from near catastrophe to face, with some confidence, the rigours of a new age. This was the optimistic message conveyed by Ernest Edmonds in bringing the EVA São Paulo International Session to a close. He predicted a wonderful future for new media artists becoming an essential element of change – change that will involve galleries and museums providing an enhanced view of the old (i.e. original works of art and artefacts) which can dramatically change our ways of appreciating them.

> All this can happen through participation by the public, participatory art, collaboration, being together, making things together (EVA-MINERVA 2021).

From the many telling points made by Ernest, I'm referencing below his comments on how museums, intent on forging a path towards a digital future, still have a duty 'to hold, present and make available the old':

> So, how do they do that? How can that duty be enhanced by the new technology? ….. Instead of the model of the museum curator holding an object, presenting it to us and telling us what we should think about it, a new model is possible where the curator presents that object and seeks our opinion, our knowledge, our anecdotes (my grandmother had one of those and she used to do so and so). Instead of the museum providing information to the public, in a one way street of activity, the museum can collaborate with the public, gaining as much as it gives, and making that available for the future…….The museum becomes a collaborator with the public, not merely a provider of information.
>
> What we see is a great opportunity for all of us in the new media art world because, all of a sudden, we're being taken notice of by the museums. But just think about the past. We owe it to our history not just to make new work that is inspired by a Van Gogh but, also, to enable people to see and appreciate Van Gogh. You can only do that by actually physically looking at the painting; a Van Gogh in a book or on a screen is not the same thing. However, new media can enable museums to help us prepare for seeing the original physical objects (EVA-MINERVA 2021 & Edmonds 2020).

Figure 4*: A digital experience, 'Van Gogh: Starry Night' at Atelier des Lumières, Paris, in 2019, took visitors on an immersive visual and musical journey of discovery through Van Gogh's famous painting.*

To prove Ernest's point, we need look no further than 'Van Gogh: Starry Night', a digital experience at Atelier des Lumières, Paris, in 2019, which took visitors on an immersive visual and musical journey of discovery through Van Gogh's famous painting (Starry Night 2019) (Figure 4). Fondation Culturespaces' initial idea, in producing this experience and many others, was to facilitate the access of sick, handicapped and otherwise deprived children to the arts and cultural heritage. However, the appeal of this type of experimental art entertainment proved to be much wider; sell-out shows, lasting a year, engaged the attention of tech-savvy younger audiences with the result that Fondation Culturespaces has now opened centres throughout France (e.g. Baux-de-Provence and Bordeaux) and further afield in Korea and Dubai. In all these locations, the exhibits complement rather than compete with galleries showing original works of art. The success of 'Van Gogh: Starry Night', for instance, in introducing young visitors to a work of art through the use of new media technology, confirms that a virtual interpretation *'can help us prepare for seeing the original physical object'* elsewhere'. Sometimes, this might be too far away to afford easy access (e.g. the original of Starry Night is in New York) but for Parisian visitors, at least, many other Van Gogh paintings lie close at-hand, in galleries ready to welcome a newly enthused audience.

3.1. Tackling the seemingly impossible

Current controversy concerning the return of art and artefacts to their original sources comes to

mind. Can a new relationship between the real and the virtual come to the rescue in situations where treasures have been obtained, either legally or otherwise, from countries that now want them back? In Athens, a new Acropolis Museum has been built with the specific aim that, one day, the Parthenon's relief carvings and sculptures, on display in the British Museum since 1817, will be returned. The doubts and arguments surrounding this issue are the cause of considerable acrimony. In anticipation that Greece will eventually win the day, the Acropolis Museum contains spaces for all the missing relief carvings of the Parthenon's frieze and the sculptures of its pediments to be displayed (Figure 5). Currently, these spaces are filled with 'temporary' plaster replicas.

Figure 5: *Parthenon Frieze, c. 438-32 B.C.E., (420 linear feet of the 525 that complete the frieze are in the British Museum) photo: Steven Zucker, CC BY-NC-SA*

The opportunities that Bernard Tschumi's architecture offers for accommodating a virtual version of the Parthenon's complete frieze and pediments causes me to put forward the contentious suggestion that the creation of an enhanced digital interpretation of the temple's magical carvings may be able to equal, and even exceed, the overall impact of the originals. Further, it would become possible, although not necessarily advisable, to digitally meld together, and even colour, images of the separated, and sometimes broken, marbles, as they currently exist in the British Museum. In saying this, I fully realise that I'm treading on many curatorial toes. The outcome I'm describing could well cause a political storm, but there's no denying the fact that the technology now exists to tackle the seemingly impossible. With further research and the wielding of considerable skill by new media artists, a world beating immersive experience of Ancient Greek life in the 5th century BC can be achieved. All concerned may then accept that the Elgin Marbles can remain in the UK, where they have been well looked after for over two centuries.

4. ART & TECHNOLOGY ACTING TOGETHER TO CREATE VIRTUAL WORLDS

In new media art, there can be no division between art and technology; as in architecture, both elements have to be melded seamlessly together to achieve success. The use of advanced technology, in itself, can never be enough. I remember a recent visit to 'Alice: Curiouser and Curiouser' at the V&A, London, where audiences were invited to tumble down the rabbit hole and embark on a mind-bending trip into Wonderland through the 'playful dimension of VR'. The reality of the experience was anti-climactic; only four headsets were available at the exhibition, with at least one always out of service. Technicians took many minutes to fit headsets on individual visitors and explain the control mechanism. The result, for me, was a long wait in a short queue that moved at a snail's pace. I lost patience and gave up after 30 minutes of waiting.

VR requiring the use of headsets can never work in a public exhibition with a large footfall. It's a problem that can be remedied, to an extent, in a Fulldome VR environment equipped with an immersive 360° projection system (i.e. 'sphere technology). In a recent example built within the Market Hall, Devonport, Plymouth, UK, the dome extends beyond the equator line to create a down-to-floor experience with many rings of speakers providing surround sound (Figure 6). Fulldomes of this type provide an environment where up to 50 people, standing or sitting at any one time on the dome's 15m diameter floor, can enjoy an immersive audio-visual experience. I see them as being suitable for performances of Visual Music – my own medium of expression (Clark, Trickett & Weinel 2021). Fulldomes, although they are available for installation in all parts of the world, have to be regarded as a specialist rather than a universal solution. At the V&A, for instance, the lack of space of sufficient height, might well have ruled them out for consideration.

Figure 6*: Diagram of a Fulldome recently opened at the Market Hall, Devonport, Plymouth, UK. It offers a VR environment where audiences, standing or sitting on a 15m diameter floor, can experience immersive audio-visual performances.*

The full spectrum of Immersive Technologies can be described as Extended Reality (XR). All are

concerned with computer technologies that allow humans to see, hear, talk, think, learn and solve problems in virtual and augmented environments. Research in AI addresses technologies that allow computing machines to mimic these same human abilities. It's these two fields, evolved separately but now unleashed together, that will impact significantly on human senses, skills and knowledge; they will enable new media artists to create evermore natural and realistic virtual worlds.

As long ago as 2006, in a Time Magazine interview, Stephen Spielberg predicted:

> Someday, in the not-too-distant future, you'll be able to go to a movie and the movie will be all around you. It'll be over your head – it'll be 360 degrees around you – even a little bit under you.

We can now achieve all of this.

4.1 The realisation of a dream

I, too, have a dream; I want to be able to experience Fion's 'Odyssey: Ride' with no boundaries or borders; to feel it and hear it all around me. If I lived in Japan, I could do just that. *teamLabBorderless* is a group of artworks that form one continuous, borderless world. Artworks move out of spaces freely, form connections and relationships with people, communicate with other works, influence and sometimes intermingle with each other and, according to the artist collective that creates *Borderless*: *"the work has the same concept as the human body".* In the exhibition space of *teamLab's Borderless* Museum in Tokyo, boulder-sized flower petals twirl and flit in infinite space, encapsulating visitors as they lie on a mirrored floor (Figure 7). Animated cherry blossoms sprout as visitors press their palms on gallery walls, creating an entire self-contained ecosystem of change and action. Floors and walls become shrouded in light projections and mirrors, space becomes boundless, and time feels limitless (teamLabBorderless 2021).

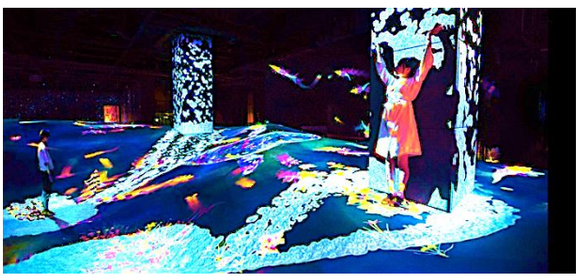

***Figure 7**: At the teamLabBorderless Museum in Tokyo, with floors and walls shrouded in animated light projections and mirrors, space becomes borderless.*

5. THE CITY OF LONDON: A TEST CASE OF POST-PANDEMIC PLANNING

Returning to home, I find that the City of London is about to enter new and relatively unexplored territory with its intention to generate international creative cooperation by joining commerce with culture and the arts in a spirit of partnership and sociability. It's a program of work which, if implemented, will take the use of Immersive Technologies to a new level and test, to the limit, the skills of new media artists using those technologies.

Last year, the City of London's Culture & Commerce Taskforce declared its intention to:

> ….reanimate the City of London's spaces in unique ways that attract people back…..and build the connections required internationally for the City to remain a global hub of commerce and become a centre for culture.

The Taskforce has recognised that the Cultural Sector has the potential to play a crucial role in the City's recovery – a city, where, like many other metropolises round the world, it can be anticipated that in a post-pandemic world up to two fifths of current office space will become surplus to requirements and, thus, become available for repurposing. It's the gradual release of this surplus space onto the market, over a period of 5 – 10 years, that will enable creative industries and cultural institutions to gain a foothold.

No doubt, the mediaeval street pattern of the City, preserved through millennia, will remain; cobbled passages, known to only a few, will continue to present a sense of history confirmed by evocative place names derived from ancient trades and sources of wealth. Charles Landry's *'think of the city as if it were a living breathing work of art'* is apt, not only for the City as it is today but, also, as a prescription for what the City can become in its new found form embracing culture as well as commerce (Landry & Bianchini 1995). For the future, closed doors forbidding entry to the City's secrets will be replaced by a new transparency where ground floor 'shop windows' will provide indications of what lies behind in reception areas made accessible as public galleries. Signs of the City's embrace of art and culture will be everywhere, not least in spaces where potential architects of the City's new found form will seek to meet a challenge of unbounded ambition (Figure 8).

***Figure 8**: Rogers Stirk Harbour + Partners' office, located on the 14th floor of the 'Cheesegrater', a building*

they designed, may indicate how, in the future, City interiors can be expected to provide the conditions for collaboration between culture and commerce. (Photo by Paul Raftery)

5.1 Culture and commerce stronger together

Of course, change to physical space, as now demanded by a depleted city, cannot in itself generate a different type of collaboration built on the respective strengths and needs of culture and commerce. It will take the 'software' of digital transformation working in close harmony with the 'hardware' of re-purposed physical space to ensure the success of the City's renewal. As an architect, I'm the first to recognise that the creation of appropriate multi-purpose spaces will place a huge demand on the City's infrastructure and necessitate the re-purposing of many of its buildings. No doubt, the performance of this immense task will stretch available professional skills to the limit, but these are tried and tested skills unlike those concerned in transforming the City's 'software'.

The software of digital transformation requires blending human potential with technology to enable creativity. Machines are not taking over the world; they rely on a process of machine learning whereby they must first be trained by humans. This idea of technology and people working symbiotically together, rather than competitively, is at the very heart of digital transformation – a fact that is firmly established in the cultural sector. For this reason, the Taskforce's plans for attracting creative cultural industries to the City, far from being blue sky, are set to move ahead at a time when the cultural sector can act as 'carriers' helping to push the commercial sector towards necessary digital transformation.

As mentioned at the outset of this paper (Section 2), proactive art galleries and museums now feel an urgent imperative to expand beyond their traditional boundaries and connect with the public through digital media displays that merge with the digital life of city streets. The way is open, therefore, for museums to transform themselves from quiet, highly organised and predictable institutions to become cultural organisations entrenched in the life of diverse communities and connected to global audiences. It's by tapping into this urge that the City can make 'Commerce and Culture stronger together'. What is now on offer is a match made in heaven where the City's commercial streets will become bathed in a new glow of cultural gold – a virtual dream, maybe, but it can be made real with guidance from our new media artists. The task ahead is both immensely complex and hugely ambitious but the City has done it before, rebuilding after the Great Fire and again after the Second World War and, more recently, in adapting to Big Bang. The City can do it again.

In facing up to this challenge, the City has yet another string to its cultural bow.

5.2 London Wall West

Once the Museum of London moves to West Smithfield, a key site located in the Northwest corner of the Square Mile will be released for development. So far, Initial ideas put forward by the City's Property Investment Board have served only to highlight the extent of the problem in defining an appropriate brief, which will not only fuel the City's ambition to 'build the connections required internationally' but, also, celebrate creativity in the widest sense of the word. Opportunities to create flexible public spaces designed to host culture working alongside commerce don't occur very often which explains why I regard London Wall West as a significant test case on how cities plan for a post-pandemic future. The eyes of the world will be watching! Will London Wall West succeed in acting as a cultural beacon in bringing people back to the City? Can it effectively demonstrate the City's new-found destiny as a global centre of culture?

To answer these questions, I'm turning to an initial scheme for London Wall West prepared by the City's appointed architects, Diller Scofidio + Renfro (DS+R), which seeks to 'amplify the creativity embedded within the area and use it to create lasting change into the future'. This is a vision that we would all like to see made real but, unfortunately, the scheme's first presentation revealed an interpretation which placed an emphasis on commercial office space to the detriment of culture activities. Given every opportunity to respond, I've put forward my own suggestion for reversing the scheme's priorities with culture taking centre stage.

A laudable aim to '*develop increased green space and pockets of nature and tranquillity'* underlay DS+R's first proposals (City of London 2021). This is a skill that the architects have demonstrated *par excellence* in their work on the High Line, New York, and now, somewhat unexpectedly, a similar opportunity presents itself in London. I'm aiming to show, in my suggestion, how DS+R's idea for a high-level green space or 'Meadow' can be extended to embrace the cultural components of a revised scheme. But, first, I should explain that this is no ordinary meadow; it has been described by the City's Property Investment Board as *'a distinctive figural bowl that creates a moment of surreal respite from the City around it with a meadow-like character'*. My transformations of this feature are indicated in plan sketches for both the Higher and Lower levels of the Meadow (Figures 9 & 11) A 'gallery' encapsulated within the undulating

structure of the Meadow provides a space for 21st century creative experimentation (Figures 10 & 11).

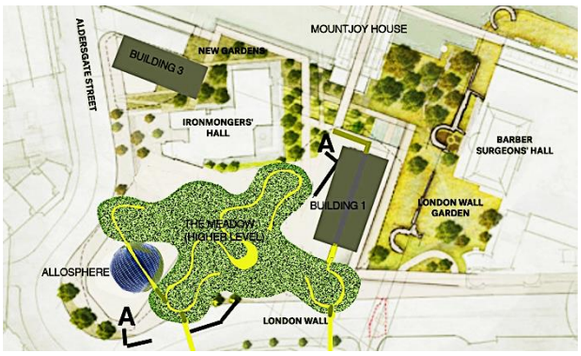

***Figure 9**: Sketch plan showing extended Meadow (Higher Level) Terry Trickett with acknowledgment to the architects for London Wall West, Diller Scofidio + Renfro.*

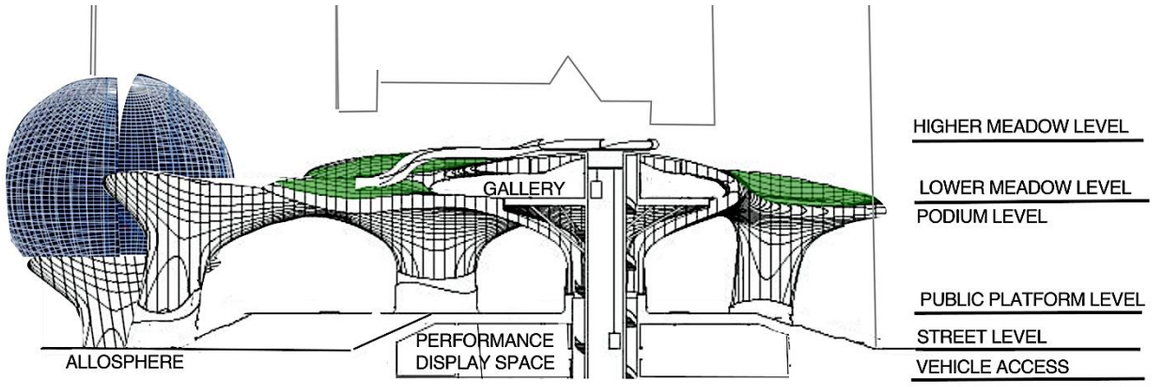

***Figure 10**: Section / Elevation AA showing the supporting structure for the Meadow and adjacent Allosphere.*

***Figure 11**: Sketch plan showing extended Meadow (Lower Level)*

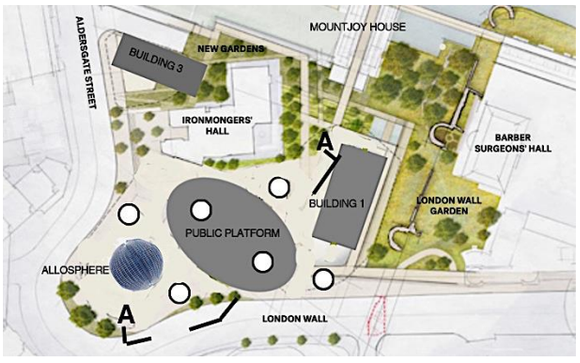

***Figure 12**: Sketch plan at Public Platform Level*

Further suggestions include a Performance and Display Space located under an elliptical Public Platform (Figure 12). Here, the aim is that galleries and museums from around the world will mount a series of illusionary/immersive displays which engage the public in state-of-the-art virtual reality experiences. This, too, is the prime purpose of the Allosphere, a large scale, immersive, surround-view instrument for both scientific and artistic experimentation positioned at the key access point to the London Wall West site (Kuchera – Morin 2021).

All the cultural elements described above are interlinked by the huge supporting structure of the Meadow (Figure 10). The overall assembly is cathedral-like in scale with a length not far off that of nearby St Pauls. It promises to offer, at both the Lower and Higher Meadow levels, opportunities for continuously changing panoramic sky-walks giving glimpses of London's remarkable two thousand year history from Roman times to its post-pandemic revival.

Inherent in the City's plans for renewal is a recognition that the more human behaviour adapts to an altered state of being digital, the less City life will depend on the places where people work and

socialise. It's a pattern of change that will be permanent which gives the City a once-in-a-lifetime chance to rebalance priorities between physicality and digitality. Building use will change dramatically but not disastrously; the need to repurpose existing structures combined with the opportunities on offer at London Wall West will enable the City to not only adapt but, also, effectively fuel and announce its creative renewal. This is a hugely ambitious task but, once achieved, the connections required internationally will be increased by the City's new-found reputation as a centre of culture with its status as a global hub for commerce retained – in all, a radical and successful transition to a post-pandemic world.

6. ENDNOTE

The picture I've painted of a post-pandemic world might surprise some readers; it doesn't echo the gloomy thoughts of a dystopian future – rather the opposite, in fact. I see the cultural aspects of life assuming a new importance in our cities, where architects, engineers, artists and technologists can play their full part in creating a physical and digital road to recovery. The priorities that we have known in the past, where a work/life balance has always been difficult to achieve, will be discarded in favour of placing a new-found emphasis on culture and leisure. I realise that it will be all too easy to lose sight of the opportunities that a post-pandemic life offers, which is why I have placed stress, in this paper, on the need to experiment with new forms of technology to enable a virtual interpretation of the past to inform the reality of our vision of the future.

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Sense of Place: Interactive installation for tourism and beyond

Kyoko Hidaka
Shibaura Institute of Technology
Tokyo, Japan
khidaka@shibaura-it.ac.jp

1. INTRODUCTION

In 2022, the pandemic is still spreading over the world, and international travel and tourism are limited all around the world. Humans always crave new experiences, but when travel is prohibited, what new ways of experiencing places are available?

Color and Communication Design Laboratory in Shibaura Institute of Technology in Tokyo, Japan has collaborated with Montfort del Rosario School of Architecture and Design of Assumption University, Suvarnabhumi Campus in Thailand to host a series of collaborative workshops and international symposia since 2019. The first workshop was held in Tokyo, the second one in Bangkok, and the third was held remotely due to a pandemic.

This study will look at the co-production of the virtual tourism experience, utilising the current, remotely conducted the Fourth Color Digital Art x Lighting International Symposium & Workshop on as a case study. The immersive nature of interactive digital art will be examined during this workshop and international symposium.

2. PRIOR DIGITAL ART PRODUCTION

Art installations are fascinating and immersive experiences, and numerous world-leading digital art organizations in Japan, such as teamLab, Rhizomatiks, and 1 to 10, have drawn attention for the method they present and the places in which they show. Immersive experiences, such as VR and AR, are very popular. Designing that enhances these immersive experiences is in high demand. It converts an ordinary environment into a new world, inspiring the experiencer's imagination and curiosity and resulting in a more gratifying experience.

3. OVERALL THEME: *SENSE OF PLACE*

Either Assumption team or I choose an overall theme for the work in each workshop. After then, the students are divided into 4-6 groups, each working on a distinct sub-theme. The dates, themes, and venues of the prior workshops are listed in table 1. The theme for this year was Sense of Place.

Table 1: *Workshops and International Symposium*

	Workshop/Symposium		
	Date	*Theme*	*Place*
1	Mar.2019	Colourful Playground for Children	Tokyo
2	Nov.2019	Illuminate	Bangkok
3	Nov.2020-Mar.2021	Ubiquitous lighting	Remote
4	Nov.2021-Mar.2022	Sense of Place	Remote

3.1 What is tourism?

Tourism is a particular issue to consider under the wider theme of Sense of Place. *"Tourism's contribution to mutual understanding and respect between peoples and communities",* writes the United Nations World Tourism Organisation (UNWTO) in Article 1 of its Global Code of Ethics for Tourism. Tourism is about more than just sensory stimulation; it's also about learning about the local culture and community.

3.2 What is immersion?

> "The body is our general medium for having a world" — Maurice Merleau-Ponty

The body's sensations are, without a doubt, the doorway to immersion. The human body, according to French phenomenological philosopher Merleau-Ponty's book, is the medium through which we

experience the world. Emotion and the senses have been the subject of interdisciplinary debate in recent years, and we want to create work that appeals to the human senses and gives the impression of a real experience, even though it is virtual. There are a variety of devices that can be used to improve reality. We hope to produce an exhibit that provides an immersive experience without the need of virtual reality headsets.

4. THE INTERNATIONAL SYMPOSIUM ON 28 FEBRUARY 2022

The group has been divided into four groups and worked on their projects in preparation for the international symposium on 28 February 2022. Around 30 students and faculty members collaborated to program microcomputers and design installations. The participants who participated remotely from Bangkok, Tokyo, China, and other locations presented creative works in the Symposium. Group 1 recreated the Northern Lights with lighting, while Group 2 produced the Indian festival of Holi with interactive art. After that, Group 3 made a virtual 3D model of a Thai temple, while Group 4 prepared a virtual tour video of Assumption University.

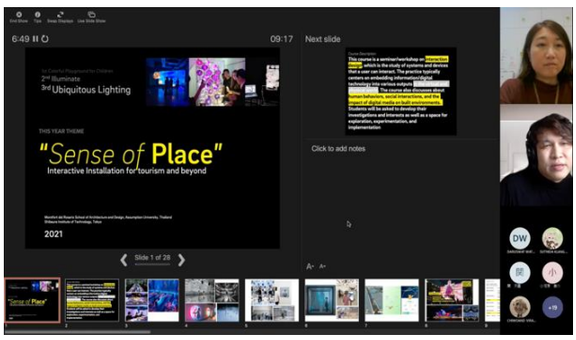

***Figure 1**. The remote workshop using Microsoft Teams (top right: Kyoko Hidaka, the author, second row: Joe Suphawong, the interactive designer).*

***Figure 2**. The tele-symposium ad banner (top: Tapanan Yeophantong, Vincent Mary School of Science and Technology, Assumption University; second row: Theerawat Klangjareonchai, the media artist).*

5. CONCLUSION

Remote workshops and symposia for digital art production may merely be a crude, but still charming attempt to recreate a sense of place. However, the opportunity to feel the presence of places that cannot be visited in reality due to pandemics or war, such as the Northern Lights in the Arctic, the Holi Festival in India, and archaeological sites or universities in Thailand, was what we intended to explore with in this workshop.

We believe that interactive digital art workshops like those can continue to play an important role in disseminating real-world information about the world and its existence in space, as well as engaging and enjoyable communities.

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Exploring Next-Generation Touch-Rich Interactions for Consumer Well-Being

Danielle Barrios-O'Neill
Royal College of Art
School of Communication,
White City Garden House,
Dorando Close, London W12 7FN, UK
d.barrios-oneill@rca.arts.ac.uk

Joskaudė Pakalkaitė
Falmouth University
The Academy of Innovation & Research, Penryn
Campus, Treliever Road, Penryn
Cornwall TR10 4RH, UK
j.pakalkaite@falmouth.ac.uk

This article critically examines the touchscreen as a lived technology and argues that next-generation devices should take advantage of more 'touch-rich' interactions. We begin from the premise that the ubiquity of touch-screen devices, combined with the frequency of use, appear to have a negative effect on consumer well-being (Lee et al. 2014; Elhai et al. 2016). Today's industry heavily relies on the image-based economy (of photographic desires, concepts, and visual attention), which significantly contributes to the information overload, unhealthy consumption of visual information through basic touch interactions and largely overlooks designing for other senses (Schroeder 2004; Shedroff 1999). The smoothness of the touchscreen provides an ideal interface for an unbroken visual information stream; this is its benefit from an industry standpoint but is also linked to several concerns regarding consumer well-being, due to an intense, constant influx of informational 'noise' (Himma 2007). We argue that the infinite stream of incoming information could be reduced by shifting focus to developing touch-rich interactions for tactile senses instead of visual-based perception, and suggest this as a clear, near- future direction for interface design, whereby touch replaces noise. Combining insights from interaction design, product design and cognitive psychology, we argue for more touch-rich interface experiences as a mode of disrupting current device conventions. We project five keyways in which touch-richness might enhance user experience, with implications for consumer well-being.

Touch. Tactility. Touch-poor interactions. Touch-rich interactions. Design for touch-rich experience.

1. INTRODUCTION

The proliferation of the touchscreen interface has in the last two decades significantly shaped patterns of technology use: swiping and scrolling, the unending newsfeed, design of hardware and software that enable ever-closer versions of the 'frictionless' interface. The seamlessness of the capacitive touchscreen can be seen as a phase in a broader trajectory in which our technologies move from visible and mechanical interfaces, toward ultimately invisible and embedded interfaces. This evolution involves, for example, the shift from button-based interaction and manipulation of physical parts to gestural movements and haptic interactions (with overlap between these) (Srinivasan & Casdogan 1997; Saffer 2008).

In the last ten years, the ability to produce hardware and software interfaces approaching the ideal of invisible and embedded has become easier and thus has accelerated. Simultaneously the cost of developing and integrating touchscreens has declined, meaning that now almost any surface can host one (White et al. 2017). Not surprisingly, smart surfaces are prime real estate for advertisers and content producers, with newsfeed apps making these spaces ever more 'sticky' via endless scrolling interfaces that deliver a high volume of 'content' extremely efficiently. This is excellent news for those who wish to keep consumers online and engaging for longer periods of time, and indeed the time spent on screen devices has increased steadily, and across a period of years coterminous with the rising popularity of touchscreen interfaces.

Perhaps not surprisingly, so much time spent staring at and interacting with touchscreens has negative effects on the well-being of consumers, where *well-being* is understood as being commensurate with 'good health' and comprising measures of physical and mental health related to

human thriving (Breslow 1972). There is widening range of research suggesting that touchscreen features have detrimental effects on many users, where frequent use of touch screen devices has been linked to compulsive engagement behaviours (endless scrolling) that has similar qualities to addiction (Weiderhold 2018), a related disruption to self-regulation (Coyne et al. 2019), and anxiety and depressive symptoms (Elhai et al. 2016). More time in noisy smart-screen environments is also shown to have a negative impact on users' cognition, manifesting as shifts in cognitive processing, dramatically diminished attention spans, delayed or deferred social skill development, and decreases in fundamental literacy skills (Ward, Duke, Gneezy & Bos 2017; Microsoft Canada 2015; Bauerlein 2008; Carr 2011; Turkle, 2011; Small & Vorgan 2008). A macro-effect is the high visual-verbal informational load, which has had a demonstrably huge effect on user experience. It's clear that our relationships with our devices are prevalent, intense, and highly consequential for well-being.

The seamless, endless, integrated, almost-invisible nature of the touchscreen is in many ways its most dangerous attribute. The screen interface is what we would describe as *touch-poor*: it is without any form of textural richness or sense-based legibility, and neglects the need for touch, or more specifically, the need for rich haptic input. Endless interactions with the texturally-blank touchscreen is the haptic equivalent of staring at a blank wall.

Touch is central for many dimensions of well-being, and this is directly related to its informational functions: hands, particularly fingers, have an extremely dense presence of nerve endings, making them one of the richest sources of tactile information we have, involved in knowledge production and sense experience even before birth. There is, not surprisingly, a large amount of evidence demonstrating how touch experience and well-being are linked. The 'need for touch' has been identified in marketing and consumer behaviour, the phrase used to describe a common trait where haptic information is highly valued and influential in decision-making (Peck & Childers 2003; Yazdanparast & Spears, 2012). Other fields bear out the 'need for touch' in terms of measurable psychological benefits: touching other humans reduces stress, touching inanimate objects and textures produces feelings of pleasure; touching natural materials increases positive emotion (see for example Feldman et al. 2010; Bhatta et al. 2017). Tactile experience can even enhance mindfulness, stabilizing and broadening the scope of attention (Stanko-Kaczmarek & Kaczmarek 2016). Yet thus far the role of touch-sensory experience in device interaction seems to have been relegated mainly to a secondary or tertiary position in design considerations. That is, touch affordances of interfaces have broadly been treated as having a supportive role in the process of accessing (textual/visual) information, rather than touch being understood more accurately as an informational process in itself (Hartson 2003; Serrano, Banos & Botella 2016).

Ours is one of several recent studies shifting away from a view of frictionless and increasingly imperceptible interfaces as the ideal design standard, toward interface designs that involve more, and more meaningful, forms of textural richness and sensual legibility. This is with the assumption that, within a trajectory of ever more integrated, invisible and efficient interfaces, the negative effects of high-volume, high-speed visual-verbal informational load will continue to intensify, unless there is intervention at the level of design and ideally of policy. In this paper we propose design interventions, arguing for a conscious directional shift in design principles that relate to interface texture and haptics. With the view that touch is an important informational process and that touch-rich experiences contribute to well-being, we identify specific user needs related to well-being that are not being fulfilled by current smart-screen interfaces, and we speculate on future directions for interface design that engage the haptic sense in better ways. We introduce the concept of *touch-richness* (TR) as a conceptual and practical design solution to many of the challenges generated by touch experience of smart screen technology.

2. TOUCH-POOR INTERACTION DESIGN

In this paper, we define touch-poor interactions (or touch-poor user experience) as lacking textural richness or sense-based legibility, and neglecting the need for rich haptic input. While 'frictionlessness' has become an accepted design standard, it is also the result of strategic interface design choices that optimise for content volume, consumer engagement in the form of clicks and views, and cultivating consumer compulsion to stay within a proprietary environment (for example a particular app) as long as possible. The outcome of design decisions motivated in this way are screen-based experiences characterised by high visual-verbal informational load (noisy, scrolling). To facilitate these experiences, haptic information is minimised, with touch interfaces broadly designed to be smooth, texture-less and physically rigid, which avoids disrupting the consumer's absorption in media content.

It has been established that humans have developed a daily 'need for touch' and a lack of fulfilment of tactile needs is also associated with lesser well-being (Patrick et al.; 2007; Peck, Wiggins & Johnson 2011). Recent research

suggests that tactile need unfulfillment is related to increased smartphone use, whereby consumers with 'high in the need for touch may demonstrate an overuse of a smartphone's touch screen to satisfy this need' (Lee et al 2014). Or to put it differently, the lack of haptic information leads the consumer to seek stimulation through visual-verbal input, intensifying the cycle of compulsive consumption (Elhai et al. 2016). This finding suggests that the touchscreen itself serves as a digital surrogate for human tactile need fulfilment. However, the need is not meaningfully fulfilled by the device, with the glassy smoothness of the mass-produced touchscreen providing only minimal sensory experience. Diversity of type, scale and material is crucially important to sensory processing, where the function of touch is of course not evolved to manipulate a perfectly smooth interface, but rather to produce diverse knowledge about physical relationships and mechanics in the world in a variety of circumstances (Lederman & Klatzky 1987).

In concrete terms, general textures such as roughness, hardness, softness, flexibility, grippiness, etc. are necessary for the haptic sense to function normally. However, these dimensions are not often nor actively incorporated into interface design for wide distribution, and they do not fit the sleek design standard that has become normal through the proliferation of mass-produced touchscreens, an aesthetic propagated by firms such as Apple. Ironically the sleek design is associated with quality and value, and yet the portability, size, shape and minimalist design conveniently and seamlessly support commercial services designed to exploit consumer resource, for example maximising time spent online, directing users to take certain actions, or encouragement of in-app purchases. These are about maximising corporate value chains, rather than representing genuine value for consumers (for whom well-being is of considerable value).

3. TOUCH-RICHNESS AS AN ALTERNATIVE DESIGN STRATEGY

Touch-rich describes hardware interface design which is rich in haptic information. Our aim in developing the TR concept is, put simply, to provide a framework that can enable designers and technology firms to develop better interfaces: better for individual quality of life, and better for broader public health and well-being. TR includes four design considerations which are also dimensions of what we're referring to as 'richness': texture, elasticity, gesturality, and interpolation. These dimensions interact to produce *touch-rich experiences*. The function of conceptualizing TR in this way is to provide a clear basis for interaction and interface designers to direct solutions in specific ways.

In the following sections we analyse established and emerging interface design concepts and prototype through a TR lens, highlighting those we find promising from a well-being perspective and provocative as design concepts. Importantly, these four dimensions of TR involve the relationship between visual-verbal informational load and haptic informational load within user experiences, where the haptic and the visual-verbal tend to be inversely related. Importantly, *informational load* refers to the *volume* of information being processed, while *richness* refers to the *type* of information being processed, where *diversity of type has greater richness*. The dimensions identified are:

Texturality: The degree to which touch experiences are diverse in feel, which enriches the haptic informational experience. For example, interfaces that are soft, ridged, have raised or etched surfaces, or unexpected or uncommon haptic feedback. An example of textural TR is the Sony Xperia Touch Projector (see Figure 1) which turns any flat surface into an interactive touchscreen (2017). This product is touch-rich in texture because it exposes users to various surfaces rather than just screens, and enriches their tactile experience, when interacting with the interfaces. A speculative example of textural TR is a 'Skin-on Interfaces' project (see Figure 2) which illustrates how artificial skin for mobiles phones provide warmer interaction and input (Teyssier 2019). Skin-like interfaces allow users to interact with the more sensitive and natural textural intention.

Figure 1: *Sony 2017. Sony Xperia Touch [projector]*

Figure 2: *Teyssier 2019. Skin-on interfaces [artificial skin for mobile devices]*

Figure 3: *Samsung 2022. Galaxy Z Flip 3 5G [smartphone]*

Figure 4: *Samsung 2022. Galaxy Z Fold 3 5G [smartphone]*

Elasticity: Touch experiences which are flexible, mutable, and organic. For example, interfaces that respond to physical touch by changing shape, feel, or temperature, thus providing a greater variety of haptic information through interaction or over time. The recent series of foldable Samsung Galaxy Z Flip 3 5G and Fold 3 5G phones are an example of elastic design TR (2021). Samsung Galaxy Z Flip 3 5G phone (see Figure 3) is a smartphone which can be flipped and folded like a compact mirror and Samsung Galaxy Z Fold 3 5G phone (see Figure 4) is a smartphone with the ability to be folded like a book. Their ability to be folded makes them touch-rich devices. A speculative example of elasticity is Shapie (see Figure 5) (2020). According to Pakalkaitė, Shapie is a touch-rich portable communication device that comes with elastic properties and the ability to change shape. Shapie has six properties that make it stand out from other communication devices: it has a thin body, it can stick and unstick from surfaces, become soft and hard again, be bent, change shape, and return to its original shape, be folded, and unfolded, which makes Shapie high in TR.

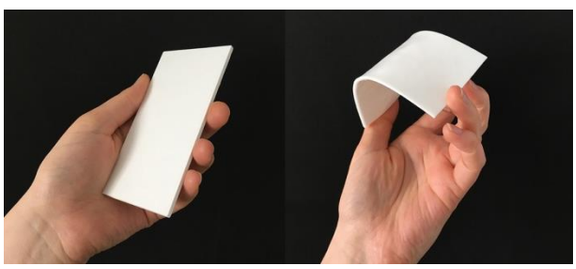

Figure 5: *Pakalkaitė 2020. Shapie [speculative prototype]*

Gesturality: The extent to which haptic experience breaks the link between direct physical contact and command. For example, swiping quickly left or right is more gestural than the drag-and-drop, requiring less touch to execute the command. Gesturality is associated with less haptic information, as there is no physical contact necessarily. For example, the Magic Leap 1 virtual headset (see Figure 6) allows users to interact with augmented reality (2020). It has accurate hand tracking technology that enables users to use hand gestures such as pointing, shaking, fist bumps and tennis serves which shows the application of high gesturality in TR. HaptX is the award-winning company which developed *HaptX* Gloves DK2 (see Figure 7) (2021). This technology enables the user to experience realistic touch such as heat, cold, and haptic realism in virtual reality. Virtual reality and augmented reality technologies and their accessories produce opportunities for designing for more haptic experiences in virtual reality that are touch-rich in gesturality.

Figure 6: *Magic Leap 2020. Magic Leap 1 [hand-tracking technology feature]*

Figure 7*: HaptX 2021. HaptX Gloves DK2 [virtual reality glove technology]*

Interpolation: The extent to which physical touch disrupts visual information flow on a device. For example, fast-scrolling functions enabled by a quick swipe are low interpolation (very little disruption of informational flow). Conversely, interfaces that require interruption of visual information flow—for example, the 4G mobile phone Punkt MP02 Pigeon (see Figure 8) has simple, tactile and grippy hardware that encourages the user to interact with the device via a tactile keyboard (Punkt 2021). This is higher interpolation, because the user is compelled to stop processing visual-verbal information to shift to tactile information processing.

Similarly, the Sidekicks project (see Figure 9) is a series of speculative objects such as an alarm clock, lamp, projector, and speaker, which can only function if the user's smartphone is placed into them (Bandi 2018). The objects are controlled with red tactile buttons and each object ceases to function if the user attempts to interact with the smartphone. This example also shows high level of interpolation in TR.

Figure 8: *Punkt 2021. MP02 Pigeon [4G mobile phone]*

Figure 9: *Bandi 2018. Sidekicks [illustration of the speculative objects]*

4. CHALLENGES TO TOUCH-RICH DESIGN

Although the need for better interface design is clear, and ways in which that can be achieved through TR can be productively applied in many cases, there are limitations respective of technological and societal, as well, as market, constraints. Digital technology favours cheap, ubiquitous duplication, and results in products and patterns of use characterised by abundance, modularity, and recombinatorial properties (fungibility). While elements of this will doubtless be embedded in different kinds of next-generation haptic interfaces, it will be, at least initially, less likely that unique hardware interface components will fit that model seamlessly, nor is it clear that they should.

This paper takes the view that, whilst there are clear and obvious barriers to introducing design principles that do not mainly and specifically serve the commercial interests of technology firms according to the current status of device use and commercial norms, there is a significant value proposition in designing to these considerations with respect to longer-term commercial and civic viability, for example changes in market trends related to mental health and well-being, innovation in experience design, and policy change concerning commercial responsibility in relation to mental health.

It's clear that the existing standard is not conducive to well-being, considering wide indicators of mental and physical health associated with overuse of devices optimized for visual-verbal information. It is interesting to consider what kinds of device interfaces might arise if there was greater attention to haptic richness by interface designers and companies both, including the importance of touch-richness to experience design and the further development of specific design methods aimed at achieving it. In practical terms, developing new hardware design is likely to involve using existing materials differently, and sourcing new materials to develop new functions (for example, shape-changing and colour-changing polymers, smart fabrics and e-textiles, soft circuit technologies, and graphene-based conductive elements) (Nabil et al. 2017). These processes can be costly to develop and may require materials that are costly to use in production. Speculative concepts and prototypes that may never become commercial products are useful in this context, to help work through the design and production challenges, toward a middle ground: realising some of the ambitions of well-being focused hardware and software interfaces, mitigating negative effects of touch-poor interactions, and developing interfaces that may even have a positive impact on well-being.

Another main challenge faced by many design researchers is measuring the benefits and impact of better design on well-being for consumers. In this case, it would be measuring whether touch-rich design is a better solution for users. Pakalkaitė explores the practical application of touch-richness by designing a speculative prototype called Shapie (2022). She argues that the use of *design fiction* and sparking the debate of the touch-rich prototype can address the potential misuses of the technology and negative impact on well-being (Sterling 2005; Dune, Raby 2014). This study is in its infancy, and touch-richness research is currently limited by the lack of data and further explorations are needed to confirm and measure whether it is a better solution to design for wellbeing.

While it's not straightforward to predict outcomes, it's easy to imagine that reducing the vast cognitive load placed on the average smartphone user's visual-verbal faculties for hours every day and redistributing this load to be shared across the senses in gentler, more diverse, and possibly more interesting ways, would have benefits to quality of life. This is likely to have even more relevance for those with forms of neurodivergence such as

ADHD, where rates of addictive behaviours related to smartphones may be more pronounced (Kwon et al., 2021). Broadly speaking, less contact with the monoculture of newsfeed doomscrolling would feasibly reduce urgency and stress for many if not most mobile device users. And even more broadly, it seems clear that having relationships with objects, such as phones, that are based on need fulfilment and pleasure, rather than addictive or compulsive attachment, would be healthier for consumers as well.

There is scope to increase the diversity of hardware interfaces, where the gravitational norm is increasingly the generic, minimalist, flat, smooth rectangle. Aside from considerations already discussed, this minimalist design described isn't a particularly inclusive one for anyone with visual impairment, literacy challenges, or upper extremity disabilities (Mi et al. 2014). Focusing on non-visual-verbal modes of information experience design are likely to provide solutions to this. Furthermore, the nature of smart interface design evolution is such that those who own smart devices with touchscreens are enculturated to a form of interface-driven (and fairly abstract) interaction norms that aren't intuitive to someone holding a smartphone for the first time but become endemic in culture due to the popularity of these devices. The lack of diversity in design leads to a generic culture of interaction, and one that may exclude those who are unable to afford expensive devices, as well as those who may not be digitally-native, to whom the devices or their habits of use may feel alien and excluding. Ultimately, a diverse public is better served by a diverse suite of design possibilities and philosophies. To the extent that the commercial potentials of touchscreens encourage all surfaces to become homes for touchscreens, the current pattern does not bode well for consumers who wish to have richer experiences and better lives.

5. IMPLICATIONS

The inclusion of speculative designs here has hopefully helped to illustrate the extent to which TR is future-focused. If TR dimensions form a series of design provocations, it's interesting and worthwhile to consider the outcomes of these provocations as they might emerge across specialized areas of interface design, such as smartphones. The implications of a normalized touch-rich experience of a smartphone, wherein rich haptic experience is integrated into the functionality of the device, might be a completely different kind of smart phone: one that changes shape in response to body position, changes texture according to who you're speaking with, measures your heart-rate so it can adapt sound and colour to reduce your stress levels, uses facial recognition technology to respond to your expressions, growing warm when you smile for example—and so on. This is not just about how we interact with devices of course, but about how they interact with us, our relationships to our objects and how we communicate through them and with them. The conscious design of touch-rich communication interfaces also has potential to change some of the fundamental coordinates of how we communicate in general. TR exists within a paradigm of care and proposing TR design assumes that comfort and intimacy are not just to be delivered in parallel to communication outcomes, but that for the sake of well-being they are necessary components of communication.

If TR was to become more widely explored by technology firms, its outcomes are likely to be interventions, processes, products and services that provide new forms of care embedded in new technologies. As such, outcomes would be complex in relation to the ethics of care-focused design, both in terms of how experiences of care are made commercial, and the ways in which forms of intimacy with devices will engender altogether new benefits, as well as new forms of risk, for human-focused interaction design. There are also complexities in balancing dimensions of TR design even in the examples given above, where responsive design features may for example work against interpolation. That is to say, change is not simple, and shifts in direction will be attended by complex discussions of the implications of every part of every new device that becomes widely adopted.

There are implications for government policy relevant to this area which we can already expect, concerning the responsibilities of commercial organizations to administer well-being as part of consumer product design. In time there could be specific conversations around the dangers of over-reliance on devices that are too effective. For example, if human-device interactions could positively shift our moods, feelings or responses without much effort, this would no doubt be interrogated as inhibiting normal emotional development, or decreasing a user's ability to self-regulate—bringing us back to the kinds of problems that we have with current technologies. More broadly however, there is an opportunity to interrupt the current trajectory toward frictionless interaction design, whose outcomes have been broadly determined according to a logic of high-volume consumption, and to design with different interests in mind: the well-being of those who use the devices.

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Did That Stone Move? Staging stone swarms in galleries and virtual reality

Elena M. Vella
The University of Melbourne, Australia
evella@student.unimelb.edu.au

Daniel A. Williams
The University of Melbourne, Australia
williamsd4@student.unimelb.edu.au

Aleks Michalewicz
The University of Melbourne, Australia
aleksm@unimelb.edu.au

Airlie Chapman
The University of Melbourne, Australia
airlie.chapman@unimelb.edu.au

Robert Ellis Walton
The University of Melbourne, Australia
robert.walton@unimelb.edu.au

This paper presents the development of a forthcoming interactive multimedia gallery installation, *Sacrifice*. We introduce the rationale to examine relationships with the human audiences and a swarm of ground robots, through collective movement to engage with audience members. In global collaboration with archaeological researchers and cultural custodians, we have developed photogrammetric models of monoliths to disguise the ground robots. We explain our tandem virtual/actual reality workflow and how it has influenced the evolution of the exhibition concept and may have benefits for practice led design on interdisciplinary projects. We anticipate that the juxtaposition of ancient stonecraft with modern robotic control technologies will provoke a wider discussion about the future of human-robot collaboration in society.

Virtual reality. Mixed reality. Swarm robotics. Human-robot interaction. Photogrammetry. Archaeology.

1. INTRODUCTION

> To change the world, we need to combine ancient wisdom with new technologies.
> —*Paulo Coelho, Warrior of the Light: A Manual*

In this paper we explore relationships between human audiences, ancient stonecraft and modern technology by examining interactions with groups of robots ('swarms') disguised as monoliths in virtual reality simulations ('VR') and in actual reality ('in real life' or 'IRL'). Multimedia performance installation *Sacrifice* requires the audience to share a gallery space with a swarm of robotic ground vehicles disguised as replica standing stones from a network of globally significant archaeological sites. We anticipate that as the stone swarm moves autonomously through space, the audience's curiosity and engagement with the performance will be stimulated.

Initial development efforts have focused on VR as a performance medium. This has enabled the tuning of key parameters of the robotic swarm's behaviours and physical appearance in order to inform the IRL exhibit. As we transition from virtual simulation to physical realisation we find ourselves in a paradoxical mixed reality of ancient, immobile stone technology strangely animated by computer controlled, semi-autonomous robots that exposes and reframes long-held appreciation of the vibrant autonomy of stony materialities in human life. Responding in part to metaphysics and object-oriented ontologies, and works on speculative realism as developed by Shaviro, we consider the perspective of the robotic stones (Shaviro 2014). In environments where humans interact with objects outside their own experience, both beliefs and physical states influence successful collaborations (Setter et al. 2016) and the new media and new material dramaturgies of performance (Eckersall et al. 2017). It is our aim to better understand how humans collaborate with stone swarms in different performance environments, both in VR and IRL.

2. ROBOTIC SWARM INTERACTIONS WITH HUMANS

Robotic swarms are groups of robots that collaborate to achieve a common goal. Coordinating agents' movements using discrete logic and communication protocols (such as mesh networks), a robotic swarm can act in multiple locations simultaneously. As the capabilities of a single robot multiply with the size of the swarm, this property of robotic swarms may be advantageous for tasks involving human-robot interactions, e.g. search and rescue or caregiving (Bartneck et al. 2004, Kozima et al. 2005, Sabanovic et al. 2006). Fundamental to the success of such missions are notions of trust, reliability, safety, and intelligibility.

In this light, an art exhibit provides a valuable opportunity to develop robotic swarm systems that interact with humans. Through this work we aim to temporarily unite human participants with the swarm in performance, ultimately to better understand how a robotic swarm's behaviours influence participant states of [dis]engagement.

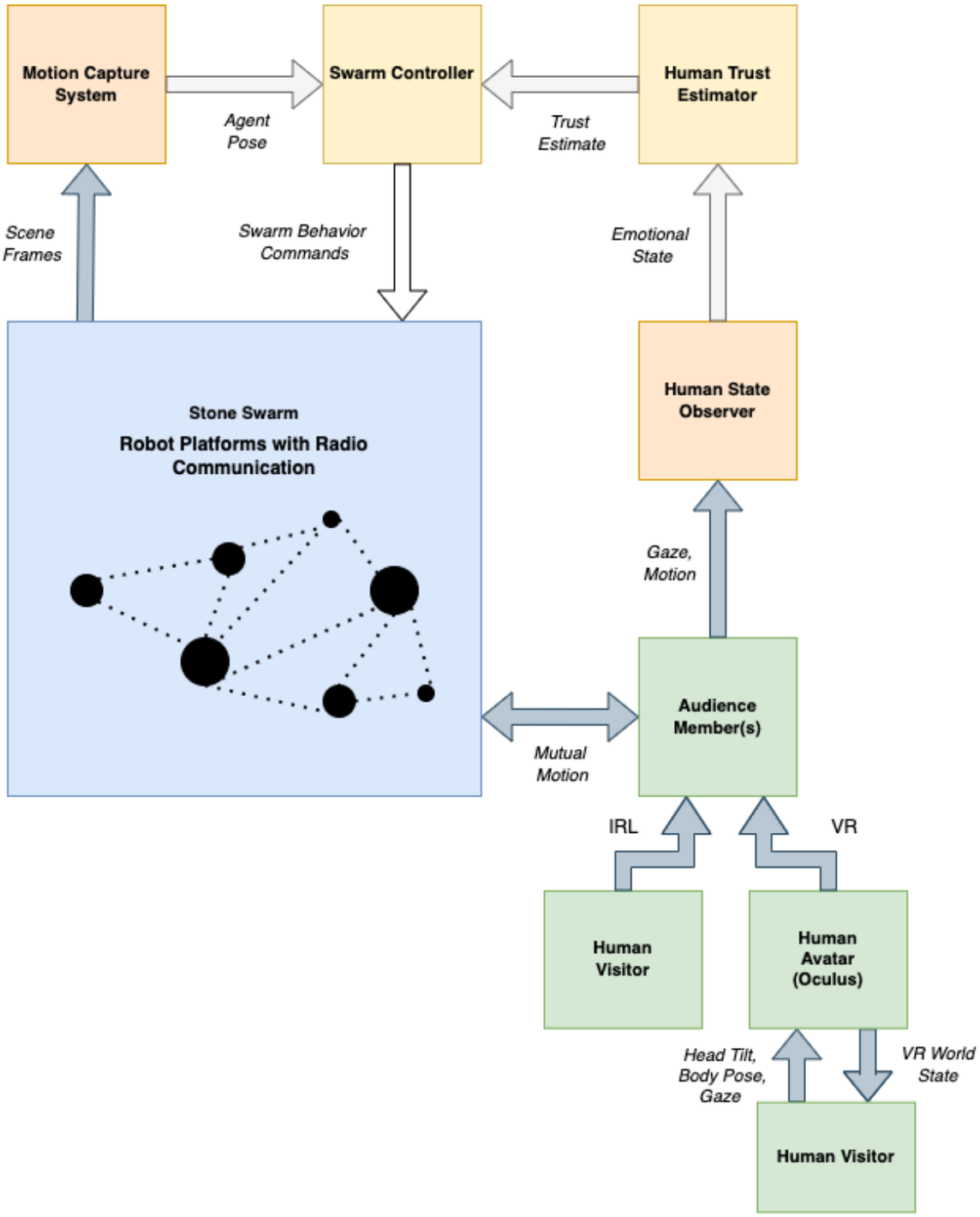

Figure 1: *Overview of communication flows between gallery components.*

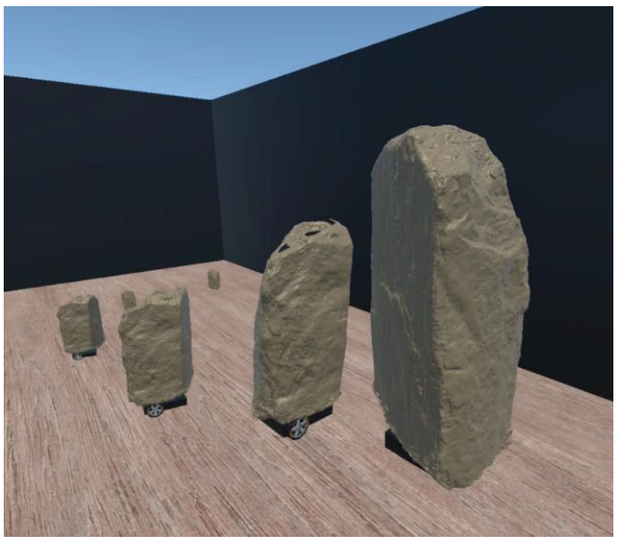

Figure 2: *View of the VR environment as seen by the artists, archaeologists and participants.*

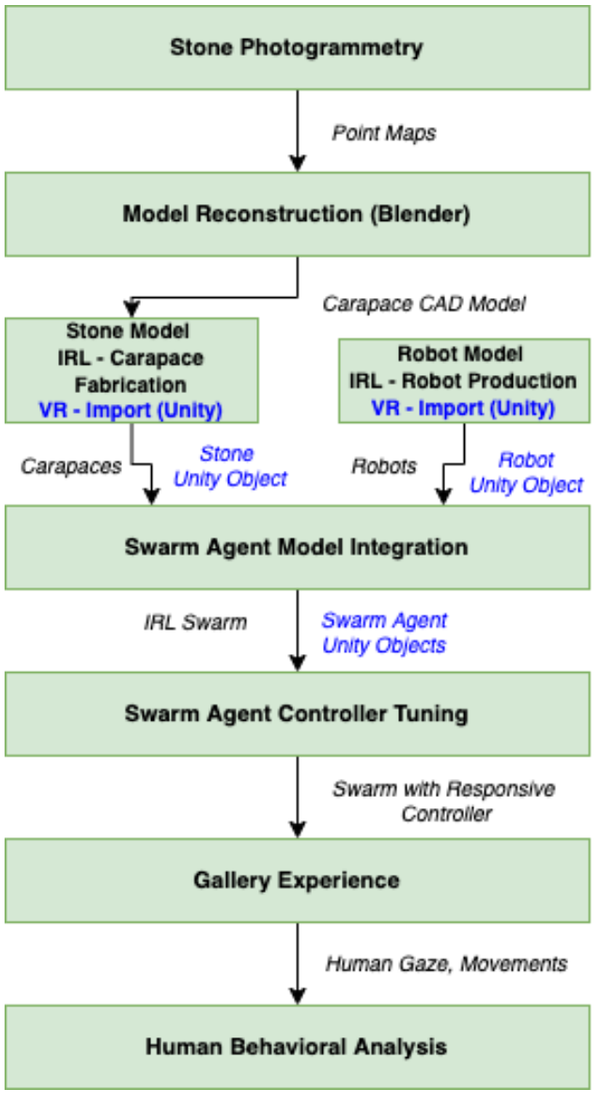

Figure 3: *IRL and VR Development Workflow – points of divergence VR noted in blue text.*

Challenges arise when integrating robotics into a performance installation due to temporal, financial, and computational constraints associated with prototyping and refining the setup (Afzal et al. 2020). Furthermore, these challenges exponentially grow when scaling from a single robot to a swarm of robots (Sahin et al. 2008). To sidestep some of these challenges, we have developed a novel VR environment for prototyping human-robotic swarm interactions for the performance. The key components involved are portrayed in Figure 1.

As depicted in Figure 2, the stages of building and refining the performance have been primarily conducted in VR to date. The continually evolving VR application has provided an immersive environment in which the team can test and observe the effects of changing certain swarm design parameters; at each iteration of development the team has been able to concretely visualise proposals for the performance, overcoming interdisciplinary communication barriers. In addition, the VR environment has enabled the collection of data regarding human behaviours and preferences. This has been used by our artists to train the robotic swarm and learn from its surroundings. We envision that the swarm will progressively learn how to interact with live audiences, adapting its behaviours to stimulate human engagement.

3. EXHIBITION DEVELOPMENT

Figure 4: *Robotic stone prototypes (miniatures).*

We shall now shift our focus from a swarm of robots to a swarm of standing stones found in archaeological sites from across the world. We have worked together with cultural custodians to develop photogrammetric models of the stones. Integral to the process of exchange, we have sought to engage with the custodians' cultural heritage, specifically the representative digital data, with care and to protect the sovereignty of these materials. Cultural considerations have included what it means to create photogrammetric models of physical stones and to transport these from their original contexts, degrees of fidelity in replicating stones, and the implications of creating a new type of site. The intentional aggregation of heterogeneous stones moving sympathetically with human participants places the latter at the heart of an evolving process of intercultural exchange. In doing so, we anticipate that the experience will provoke contemplation about the common elements between humanity's relationships with ancient and modern technologies: robotic swarms and ancient standing stones.

Having concentrated on a purely VR-based performance experience initially, we have begun to transition to a mixed reality experience (Benford & Giannachi 2011). Following the workflow summarised in Figure 3, our team is currently prototyping the designs of the standing stone carapaces and tuning the physical robots' controllers accordingly; differences in virtual development are highlighted in blue. At the same time, we are continually refining the VR experience to keep it closely aligned with the forthcoming IRL gallery experience. The common structure of the VR and IRL simulation systems (depicted in Figures 1 and 4 respectively) has allowed us to rapidly transfer behaviours implemented in VR to the robotic platforms with a degree of confidence. By implementing parallel VR and IRL experiences for the gallery space, we will be able to experiment with the volume and format of information to convey to human participants. This will result in a multilayered and multivocal IRL and VR experience for audiences. Our ultimate goal is to use these observations to yield insights into how human trust can evolve in response to changes in the swarm experience.

4. CONCLUSIONS

Preliminary findings from the development of *Sacrifice* provide evidence for a greater crossover between swarm robotics, art and mixed reality experiences. Using modern photogrammetric techniques we have sought to document and aggregate elements of cultural heritage from multiple archaeological sites globally. In addition, we have underlined the importance of extending the use of robot swarms in performances for the general public. In turn, this prompts a wider discussion about humans collaborating with robotic technologies *in performance* both in heightened arts settings and more mundane quotidian encounters in society. We continue to develop new ways of interpreting and structuring human-robot interactions in VR and IRL settings. We anticipate that *Sacrifice* will evolve further as the gallery performance takes shape, allowing us to explore the expressive potential of hybrid mixed reality experiences.

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Show must go on? Problems of bio art preservation in the example *Plant~Animals* (2021–) by Elvin Flamingo

Sonia Milewska
Art conservator
Poland
soniami.art@gmail.com

The paper examines problems of exhibiting, storing and preserving of media art. I demonstrate the challenges of exposure and maintenance of artworks with non-human habitats using the example of Elvin Flamingo's bio art installation *Plant~Animals* (2021-). Bioethics will be discussed in relation to bio art display and conservation, as well as the study of co-authorship. The paper aims to show that posthumanist rhetoric has a significant role in the preservation of Elvin Flamingo's works of art.
I investigate various conservation strategies for works from the *Symbiosity of Creation* series, including the use of virtual reality in the preservation of media art.

Media art preservation. Bio art. Contemporary art conservation.

1. INTRODUCTION

At the beginning of the new millennium, Eduardo Kac presented Alba (2000) – a rabbit engineered to express the green fluorescent protein (GFP). The public had only seen the animal in images, but in the same year, Marta de Menezes' work of art, *Nature?* (1999), was available to experience in real time (Kac 2007, p.219). Although the last two decades have seen a constant trend in institutions' caution and reserve in exhibiting bio art. While the genre is present, and like any other work, bio art deteriorates and requires maintenance. In general, media art events rarely include living creatures in shows, but there are exceptions. Elvin Flamingo, a Polish artist, has been designing large-scale habitats for non-human organisms for over ten years, bringing new challenges to audiences, curators, and art conservators.

The article will illustrate the challenges of exposure and preservation of artworks with non-human habitats using Elvin Flamingo's *Symbiosity of Creation* as an example. Bioethics will be discussed in relation to bio art display and conservation, as well as the study of co-authorship. The study aims to demonstrate that posthumanist rhetoric has a significant role in the preservation of Elvin Flamingo's works of art. The purpose of this paper is to review the arguments for showing bio artworks and emphasise, according to the idea of *Symbiosity of Creation*, the importance of the presence of all actors of *Plant~Animals*.

Using the Decision Making Model based on the experiences of contemporary art conservators, various scenarios for the art protection will be considered, including the usage of modern technology like virtual reality. These conservation paths will serve as the framework for developing a preservation strategy for works in *the Symbiosity of Creation* series, but also will be a contribution to the field of media art conservation. This research provides a case study for bio art curators and conservators, as well as an addition to the literature that recognises posthumanist analysis and virtual reality in the preservation of media art.

2. ACTORS

2.1 Elvin Flamingo

The main author of the project, and part of it at the same time, is a Polish artist Elvin Flamingo, real name Jarosław Czarnecki. He is a designer with a graphic and video practical background. He continues to use his cinema knowledge in his most recent initiatives, which combine art, biology, and technology. Elvin Flamingo is a modern artist

working in the field of bio art who exhibits at the largest media art festivals in Poland – Media Art Biennale WRO in Wrocław, and around the world – *Plant~Animals* (Fig.1,4), the main subject of this paper, was a part of the program of Ars Electronica 2021.

2.2 *Plant~Animals*

Another important actor in *Plant~Animals* installation is *Symsagittifera roscoffensis* (Fig.2, 5), worms for which Elvin Flamingo built whole installation with two incubators. These flatworms are both – a plant and an animal. *Symsagittifera roscoffensis* is transparent, but owe its green colour to the tiny cells of the *Platymonas* algae that pass inside the body of flatworm. Those non-human beings require the creation of appropriate conditions in an environment other than the natural sea coast, such as: a temperature of 14 ° C, ph 8.2 sea water about salinity 3,3% (Flamingo's website). The conditions and forms of life that the flatworm takes are important in the context of the protection of the ecosystem and thus the entire installation.

2.3 Incubators

Installation consists of two incubators with *Symsagittifera roscoffensis* worm habitats and the equipment for looking after and looking at them. The incubators with a total cubature of 0.5 m³ are set on metal, white cross-welded tables with wood-glass structures resembling a train station, in which are located both: equipment and habitats. Inside incubators are tools to care for them. All of the equipment is designed to provide the best conditions for the worm's survival while also allowing researchers to examine non-human social movements, interdependencies, and interactions with humans. The relationship prominent in Elvin Flamingo's *Symbiosity of Creation* concept is explored in this study on behaviour and networks.

Figure 1: *Plant~Animals ~ Symbiosity of Creation by Elvin Flamingo (2021). Courtesy of the artist*

Figure 2: *Plant~Animals ~ Symbiosity of Creation by Elvin Flamingo (2021). Courtesy of the artist*

3. NO SCRIPT

Elvin Flamingo's film interests are prominent in his bio artworks, as he underlines while discussing the motivation for *Plant~Animals*. The artist refers two incubators, or actually the plans inside them, to Lars von Trier's movies *Dogville* (2003) and *Manderlay* (2005). It is an open form that doesn't require a script or a research protocol as the artist underlines, which is crucial when considering Elvin Flamingo's entire body of work. This is a one-of-a-kind experiment, just like the two discussed von Trier's films, and the described *Symbiosity of Creation* is an idea of Elvin Flamingo in harmony with which he has been working since 2012 (Flamingo 2014).

Symbiosity of Creation is Elvin Flamingo's artistic approach, which he characterises as 'interactive and symbiotic relationship of creating common work' (Flamingo 2014, p.25). There is no single author in the symbiotic process, and Elvin Flamingo claims that he was obliged to take on the role of co-creator, or even that he is only one of the many actors who are constructing this network – 'shared quotidian.' The artist used the *Symbiotic Art Manifesto* by Leonel Moura and Henrique Garcia Pereira from 2004 to develop a framework for the project, detailing the guidelines of his approach termed *Symbiosity of Creation* (Flamingo 2014, p.40) by following these principles:

- change in the position of the author from the demiurge to participant,
- departure from narcissism and concentration on the artist,
- redefinition of interactivity understood as the relationship of living beings: humans and non-humans,
- departure from the conviction that everything can be art,

- rejection of any manifestations of arrogance,
- full respect for all participating beings,
- constant creation of the work even if it is not exhibited,
- artwork as a process in which every step of human or non-human is important and dependent on each other, without evaluating which is more important.

First piece of *Symbiosity of Creation* was the ants habitat *Reconstruction of Non-human Culture* (Fig. 3) that has the beginning in 2012 and it continues till now. The project began with attempts to construct a farm ant colony, and the author set a completion date of 2034, which is the foreseeable moment of the queen ant's death, as it is the end of the entire kingdom. Initially, the installation was divided into four incubators, each of which was specially made by the artist, but was later modified and reconfigured by ants. Elvin Flamingo devoted a few years for everyday care after colonies and he reflected that 'beyond the incubators [...] this work is nothing more than the shared quotidian of me and my ants' (Flamingo 2014, p.25).

Figure 3*: The Symbiosity of Creation / Reconstruction of Non-human Culture by Elvin Flamingo (2012-). Courtesy of the artist.*

4. CO-AUTHORSHIP

The investigation of Elvin Flamingo's artworks reveals a number of intriguing concerns on the problem map. First, his works are part of the bio art genre, which is similar to using scientific laboratories as artists' studios. Second, the artist's laboratory activities include the research of posthumanist philosophy and a critique of anthropocentrism. Finally, the most important feature of his work is his search for the quotidian in art, as well as his collaboration with non-human species in the creation of Symbiosity of Creation. Elvin Flamingo underlines the significance of the work, imbuing it with posthuman ideas.

Plant~Animals, for example, can be classed as a type of bio art that preserves the laboratory accuracy scheme, in which live animals are caged and watched, and analyses the complex of 'dependency-responsibility-information' as Viola and Piotr Krajewscy describe (Krajewscy 2015, p.60). The project illustrates cooperation between art and science, artist and scientist, therefore similarity of tools, exchange of observations and experiences drawn by Victoria Vesna (Vesna 2011, pp.15-21). Ryszard W. Kluszczyński describes this distinctive new way of combining art, science, and technology through the example of The Tissue Culture & Art Project, which relocates scientific laboratories to galleries and art institutions, allowing viewers to see works of art as 'the realm of everyday life' (Kluszczyński 2012, p.78) as in the work of Elvin Flamingo.

The rejection of the divide of culture and nature after Bruno Latour, as well as his 'actor-network' theory, (Latour 2005) may be seen in Elvin Flamingo's works. The artist firstly underlined the rejection of arrogance and anthropocentrism, emphasizing the threat that Timothy Morton describes in *Dark ecology* (2016) and then he redirected attention from human life to non-human life forms. Monika Bakke's book (Bakke 2012) covers artistic actions in the sphere of visual arts that contribute to the establishment and deepening of posthumanist views, and this activity might be referenced there. According to Bakke, the human subject opens out to a diversity of life forms, or to the non-human universe in which he actively and passively participates (Bakke 2012, p.232) – and this co-participation is linked to the major idea of *Symbiosity of Creation.*

The key word 'symbiosis' has multiple meanings in terms of *Plan-Animals*: firstly it indicates the symbiotic nature of the two organisms of the flatworm and algae, but also the co-existence of this organism with the artist, furthermore posthumanist discourse on symbioticism and 'companion species' by Donna Haraway (Haraway 2003). Elvin Flamingo emphasised the symbiosis not only in the word 'symbiosity,' but also in his new interpretation of the manifesto: in redefining interactivity in general relations between living beings, people and non-people, or in emphasizing full respect for all beings, treating them equally, towards *zoe* – the perspective of life in general. The artist not only recognises the significance of the non-human element in his work, but also highlights that each side has a creative influence on the other, regardless of who is more essential.

Therefore, it can be summarised after Bakke that culture in its various forms, including its 'scientific incarnations', is produced by both humans and

non-humans. On top of that, the artist himself says about *Reconstruction of Non-human Culture* as 'one of the thousands of actors-workers in the networks' and 'beyond the incubators [...] in which ants live and reproduce' (Flamingo 2014, p.25). Just like Haraway proposed the concept of becoming with animals, emphasizing 'symbiosity', where different species are in fact participants in our vital processes (Bakke 2012, p.95).

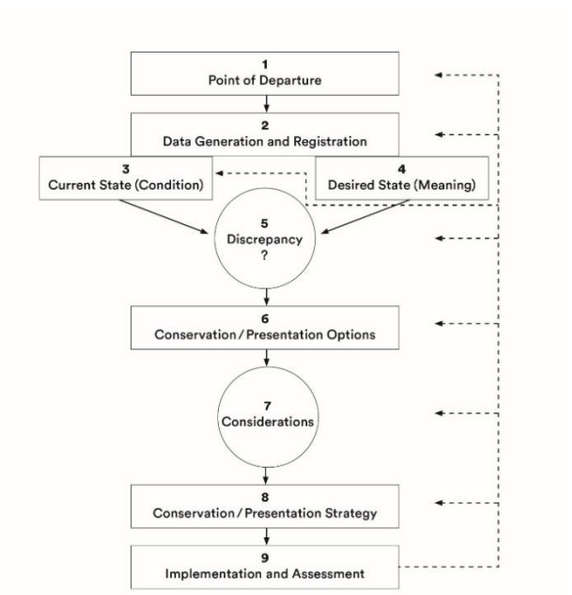
5. ACTION OR NO ACTION

The current state of study indicates that time-based-media conservation, particularly bio art, is still a continuing process. However, media art, like experimental forms and new technology that soon lose their properties, requires conservation care. The presence of biological elements in bio art, in particular bio-transfigurations, requires not just a materials science but also an ethical perspective. Jens Hauser wrote about the protection of bio art that it is aging like a film – leaving behind documents, photos, posters or flyers, which further recall the process of 'new life itself in the manner of a synecdoche' (Hauser 2005, p.185). Therefore, consideration of conservators includes not only the works themselves, but also the documentation, artifacts and emotions they leave behind.

The materiality of artworks, but even more so intangible values, are at the centre of the modern art conservation strategy. The variety of techniques, technologies, styles and materials, as well as the approach of artists, does not allow for the designation of a specific conservation path like methodology assigned to certain types of classic art. Caste studies and work patterns developed by conservators themselves are the main sources of improvement in a maintenance strategy of modern art. The most important tool is The Decision Making Model for Contemporary Art Conservation and Presentation (Tabl.1.) in which the individual elements of a work are valued to determine its significance, thus to establish a conservation strategy for a particular artwork (SBMK 1999, TH Köln 2019).

Following the Decision Making Model, it can be condensed that the idea of *Symbiosity of Creation* series is the artist's coexistence with living organisms in an artificial, quasi-laboratory environment that he built for them. In the case of an ant habitat, non-human actors have been kept alive as one continuous colony since 2012, but flatworm habitats are replaced shortly after several weeks or days after their natural death. The idea is to maintain this relationship between both actors: 'My works are works of art only when he lives, exists and works with them. When I am gone my art disappears' says Elvin Flamingo (Flamingo's website) and this quote will define the entire strategy of conservation.

Table 1: *Decision Making Model for Contemporary Art Conservation and Presentation. TH Koln.*



In the *Symbiosity of Creation*, in order for the work of art be complete, following actors are needed: human and non-human being in an (non)artificial environment created by the artist. Therefore, scenarios in which some of these elements are missing should be discussed.

5.1 No Incubators

Material construction of incubators are relatively important, only those referring to the Hamburg train station and hand-made by Elvin Flamingo have an artistic value, but all laboratory equipment is replaceable. The artist respects the passage of time; therefore he would leave small damages as long as they do not affect the functionality of the work. The author talks about incubators as warehouses and in the utopian version of the project, where all actors merge into one, says that he himself could become such an incubator for flatworms. The conversation also features inspiration from von Trier's films and his unfinished trilogy, Elvin Flamingo allows for the hypothetical extension of the installation also by this third part, not necessarily even in the form of an incubator. It's worth mentioning that because the environment can be expanded, it can also augment into a virtual form, allowing the environment to take on a variety of shapes – following the principle that works of media art are characterised by variability and changeability according to the studies of Hanna B. Hölling (Hölling 2017).

5.2 No flatworms

Flatworms, unlike ants whose life dictates the end of the artwork, are replaced when they die, so conservation is about maintaining the continuity of the habitat, thus cooperating with Station Biologique de Roscoff that delivers these creatures. Equally important is a transport, also in terms of changing legal issues. In this instance, the best option is to take care of flatworms or to take no action – which would mean the end of the work. In that situation, only the presentation of previous performances, documentation, and artifacts will be a possible preservation method.

Bio art in the form of a laboratory is by definition a field for experiments and a place for techno-artistic reflections, including ethical ones. The subject is widely analysed in Hauser's research, or in Joanna Zylinska's book where she debated on 'new bioethics beyond analytical philosophy' and writes about responsibility (Zylinska 2009). In terms of Elvin Flamingo's artworks, his scientific research should be highlighted, as well as his kinship – the artist said that if even one small worm dies, he dies with it. The question of ethics in terms is whether the artist would pass this responsibility onto someone else, which leads to the last scenario to consider.

5.3 No artist

The quote 'When I'm gone my art disappears' should be repeated here again because it has impact on the strategy of preservation. Although Elvin Flamingo creates an artistic manifesto which is a categorical departure from the artist's egoistic positioning in the centre, he admits that *Symbiosity of Creation* does not exist without him. Following and respecting artistic statements, *Plant~Animals* should not be displayed as an incomplete work of art. In this case, alternative preservation options are proposed.

If treat *Symbiosity of Creation* as a 'kind of 'biotheater', the policy of preservation should be analogous to performance preservation, that is conservation through documentation. This form of protection includes archiving or presenting photographic documentation, video, 360 or VR projection in which immersive viewers could watch non-human colonies, for example from the artist's perspective. The participant would virtually complement the required three actors avoiding discussed ethical responsibility.

In order to consider each option of the preservation / presentation strategy, Elvin Flamingo was asked how he imagine the works in a hundred years. In the interview, he emphasised that along with the takeover of the work by the new owner, he has no control, but still trusts restorers, curators and art historians in the matter of preservation. In the context of an unknown future, he is interested in more fascinating approaches to the subject of conservation, which could be the creation of his clone – as regards, he allows the option of a complete reproduction of the artwork, reconstruction of *Symbiosity of Creation*.

Elvin Flamingo, being fully consistent in his activities as part of the *Symbiosity of Creation*, underlines that installations are only created when he is a part of them. As a result, these events can be viewed as performances and protected such as. About the relationship between real presence and metaphorical representation in performance wrote Hauser. His quote will emphasise the importance of Elvin Flamingo's role in his artworks: 'Whereas the theatrical actor still metaphorically embodies a role, the performance artist brings his own body and his own real biography into play' (Hauser 2005, p.184).

One of the important steps in the conservation strategy is examining similar examples. The post-conference *Living Matter* publication of the Getty Conservation Institute will undoubtedly be a suitable source to find works in which biological material was used just once or is replaced on each display (not yet published, Getty Institute website). Along with the review, I will cite an intervention *The Theater of Disappearance* by Villar Rojas who refers his work to 'parasitic relationship'. This is an example of an artist with a different mentality — parasitism rather than symbiosis, as Elvin Flamingo suggests – but it still places a major focus on the artist's involvement in co-creating the piece of art.

To summarise, the conservation strategy should aim to maintain the show with all actors. In terms of *Plant~Animals,* the work of art does not exist without a colony of worms placed in warehouses that are looked after by the artist. The artwork may be, according to the author, but does not have to be watched by viewers – the piece of art lasts even outside the official exhibition, if only the actors are alive and present. Due to the biological nature of the actors, the forms of presentation of the work should also be considered within other realities.

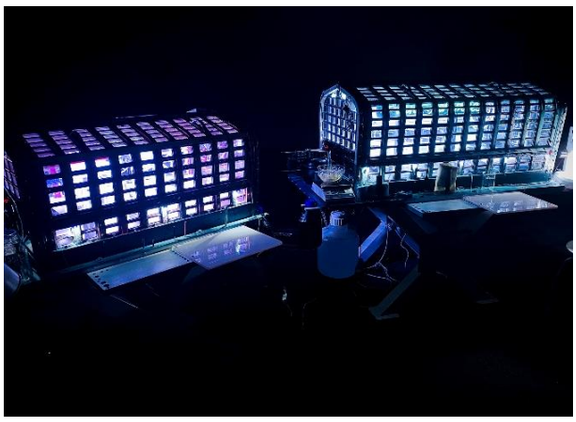


Figure 4: *Plant~Animals ~ Symbiosity of Creation by Elvin Flamingo (2021). Courtesy of the artist.*

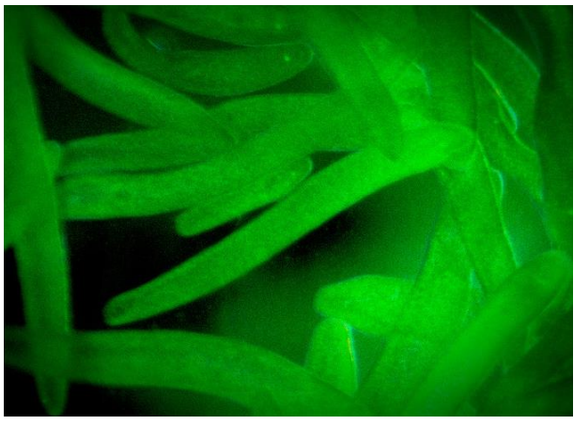


Figure 5: *Plant~Animals ~ Symbiosity of Creation by Elvin Flamingo (2021). Courtesy of the artist*

Figure 6: *Plant~Animals ~ Symbiosity of Creation by Elvin Flamingo (2021). Courtesy of the artist*

6. CONCLUSION

Plant~Animals is a unique example of an extensive bio art installation characterised by: interdisciplinary cooperation, transdisciplinary, hybridity, scientific rationality and what is most relevant, emotional empathy and symbiosis with non-human beings. The study has shown that the greatest researchers' concern – bioethics, is determined by art projects such as Elvin Flamingo. As evidenced by his approach, who rejects the artist's decisive stance in his credo *Symbiosity of Creation* and defines art as coexistence and co-creation with non-humans. Following this rule, which was established in the course of the analysis of the work and the authors, various paths of the conservation strategy were proposed. In the paper, multiple analysis revealed that not only the focus on the scientific part of bio art, but the posthumanist theories explain the meaning of the artwork and the subsequent assessment of the audience: observers, curators, art conservators.

Using the Decision Making Model tool, the following conclusion are drawn from the present study. The care plan proposed for Elvin Flamingo's work *Plant~Animals* serves as the foundation for the protection of works from the *Symbiosity of Creation* series, but also provides a framework for the exploration of the bio art conservation process. These results may not applicable to all bio artworks, but in the absence of further research, It can be used as a model for similar case studies. Furthermore, a technique for avoiding the bioethics dilemma was presented: transferring the experiment into virtual reality. This study has demonstrated that the artistic idea of *Symbiosity of Creation* focuses on co-creation and 'shared quotidian', using the borrowed term 'biotheatre' should be treated as a kind of performance. Despite some restrictions in terms of preserving this type of work, there are two primary approaches: preservation as presentation by documentation or 'show must go on'.

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Structures of Emotion: An online demonstration of an emotion recognition process

Avital Meshi
Performance Studies, UC Davis
USA
ameshi@ucdavis.edu

Treyden Chiaravalloti
Independent Artist
USA
treyden3@gmail.com

1. INTRODUCTION

Structures of Emotion is an art performance that aims to examine the way humans and machines read and interpret emotional expressions. The work realises the difficulty of translating 'feelings' into words. We analyse the proprioceptive and cognitive complexity of emotion recognition, comparing human vs. computer vision's biases while perceiving another person. Through this relationship emotions are reduced to a sensory input given by the subject's facial expressions. The relationship is mediated by a digital screen, which obstructs other biometric inputs that would otherwise be delivered in person. This ocular-centric, remote mode of communication has become a primary channel for social interactions.

When we see someone smiling, does it necessarily mean that this person is 'Happy'? Our need to conceptualise and translate facial expressions into language is part of a natural learning process by which we attempt to understand the world. This process is innately reductive and biased due to the fact that we observe another person through only one perspective. The work examines how others see us and how this, in return, changes our behavioural responses. When we are told that we seem tired, angry, or sad the impact on our emotional response will vary depending on whether the feedback is produced by a human vs. a computer.

Figure 1: *A screen grab from an online demonstration of Structures of Emotion. The two performers are shown on the right two panels. The upper performer represents the machine by wearing the AI device and estimating emotions. The second performer represents the human vision by simply looking at the participant and estimating their emotions. On the left panel is the participant whose emotions are being estimated.*

Technologies that we design reflect our world views. The AI system used in this project is trained to recognise facial expressions according to a pre-determined list of seven human-defined primary emotions. Systems built on this premise estimate aspects of an individual's identity or state of mind based on external appearances through Eurocentric codes. This design brings to mind pseudo-scientific physiognomic practices, which are notorious for their discriminatory nature and must be addressed in AI-based computer vision algorithms. The comparison between AI and human analysis of facial expressions reminds us that the technology is far from maturing beyond its maker, and both humans and machines still have much to learn.

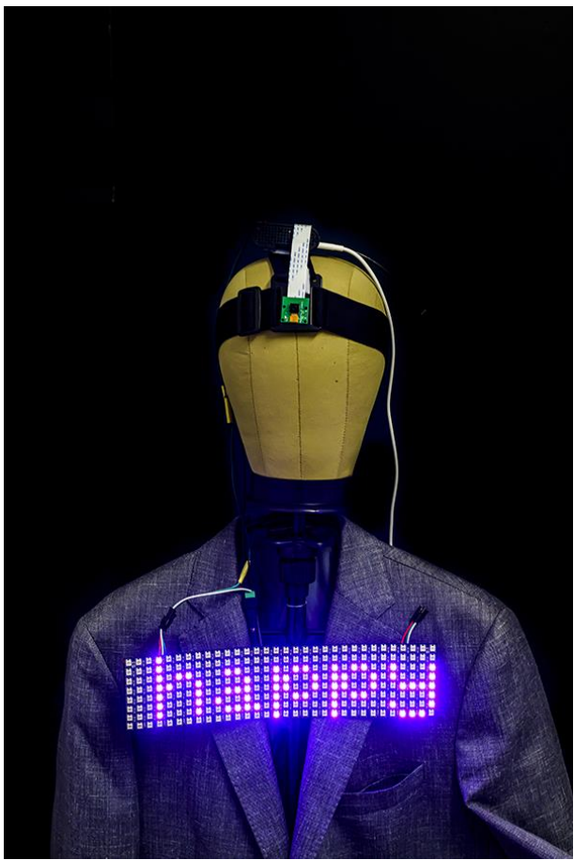

Figure 2: *The wearable device used in the performance Structures of Emotion. Image by Kyle Adler.*

2. DETAILS OF THE AI WEARABLE DEVICE

The device used in *Structures of Emotion* (Figure 2) is composed of a micro-controller that hosts an off-the-shelf AI algorithm, pre-trained to recognise a person's face and estimate the emotions: Happy, Sad, Angry, Disgusted, Fearful, Surprised, and Neutral. The algorithm used for this device is outsourced from the online GitHub community (Omar178 2022).

The micro-processor is attached to the performer's head and a tiny camera is attached to the performer's forehead. This allows a live stream that enables real-time emotion recognition processing from the first-person perspective of the wearer. When the algorithm detects a person's face, it estimates their apparent emotion and displays it on an LED panel attached to the performer's chest. It also announces the estimated emotion out loud through a Bluetooth speaker connected to the wearable device. If the person who stands in front of the performer smiles, the algorithm will likely estimate them as happy. The LED panel will light up with the sentence "YOU SEEM HAPPY," and this sentence will also be announced out loud.

3. DETAILS OF THE DEMONSTRATION

The online demonstration of *Structures of Emotion* takes place on an online video conference. It includes two performers who attempt to analyse a participant's emotions; One performer is aided by the AI device described above and the other performer estimates emotions through the perspective of a human being, by simply using their own organic senses (Figure 1). The demonstration lasts about 10-15 minutes with each participant. The performers observe the participant's facial expressions and attempt to recognise their emotions. The participant is welcome to respond or remain silent. As the performance culminates a conversation transitions the relationship by inviting the participants to communicate their emotions and then analyse those of the performers and of the machine.

4. CONCLUSION

A strictly visual approach to emotion recognition is a reductive interpretation of the sensory information required to analyse the complex neurobiological system of human emotion. AI's simplistic vocabulary and its reliance on appearance make it unreliable. With that, it is essential to ask whether or not a human's interpretation of the emotions of others is any more accurate. The art demonstration of *Structures of Emotion* is aimed at provoking a conversation regarding biases that are implicit in both the human and nonhuman gaze. It inspires a reconsideration of the framework by which we understand emotions through the body and with language. Lastly, the work speculates a trans-humanist future in which a wearable AI enables access to multiple perspectives. In this case, we strongly advocate that emotion recognition algorithms should be designed ethically as tools that promote human agency and autonomy over our emotional states.

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Umwelt Hacking: Can we sense like a forest, a mycelium network or an octopus?

Carl Hayden Smith
Learning Technology Research
Centre, Ravensbourne University
London, 6 Penrose Way, Greenwich
Peninsula, London SE10 0EW, UK
c.smith@rave.ac.uk

Roseanne Wakely
Rusty Squid
Albion Dockside Estate
Hanover Place
Bristol, BS1 6UT, UK
roseanne.wakely@gmail.com

Can we sense like a forest, a mycelium network or an octopus? Each of these is their own 'kingdom' so how do we build sensory bridges between these kingdoms? This paper explores expanding the definition of intelligence, seeking to find a bridge between what humans can sense, and what a forest, mycelium network or octopus can. The project came out of the observation that our human metric of intelligence is flawed, there seems to be a hierarchical and binary approach, alongside a predominant belief that what we consider is quite narrow and fixed, aligning with what computers can do, favouring speed, efficiency, and memory. This excludes the richness of neurodiversity and people with radically different abilities. Building on previous projects and experiments we have conducted several experiments exploring the transfer process involved in sensing like a forest, a mycelium network or an octopus

Umwelt hacking. Neurodiversity. Prosthetics. Immersive. Biohacking.

1. INTRODUCTION

An Umwelt is the world as it is experienced by a particular organism, it is a “closed unit” consisting of all an organism can sense and act on. Our research asks if that private world is the only world, it can know and experience.

Umwelt Hacking is not new, in 1974 a paper by Thomas Nagel, asked “What is it like to be a bat?” (Nagel 1974) and in 1934 a theoretical biologist, Jakob von Uexküll asked what it is like to be a tick (von Uexkull 1934).

von Uexküll even did early Umwelt hacking experiments using a variety of media:

> Von Uexkül does not just tell us what these umwelts are like. He shows us — or tries, anyway, using inventive illustrations and sometimes photographic gimmickry. In one series of his figures, a first photograph shows a village scene as we might experience it ourselves; the next shows the same scene photographed through a screen, to simulate the cruder visual resolution that others species experience. He then goes another step, photographing the photograph through a screen, rendering the village that much as coarser. As a fly might see it, or a mollusk (Cooperrider 2020).

Humans have a habit of believing that they are separate and above nature. There is a prevalent culture based on an assumption that humans have the ultimate intelligence and that anything other than human intelligence is less than. These two factors have a major impact on how humans mistreat their environment. This also impacts upon the neurodiverse community, creating a feeling of being inadequate. We have a hypothesis that more empathy (and compassion) between people and nature could help close this gap. We have chosen to explore 3 entities from 3 kingdoms: Forest / Mycelium network / Octopus.

The goal is to make playful physical prosthetics that could create a bridge between what these entities experience and what humans experience.

For each kingdom we ask:

- Can we sense like a forest?
- Can we sense like a mycelium network?
- Can we sense like an octopus?

All three have a unique way of being in the world and experience life very differently.

2. NEURODIVERSITY

> How do we recognise what is forest, when we don't even recognise what is human? We clear the understory in the same way we scrub our outer biome – removing essential elements and leaving areas barren and vulnerable. – Jay Cousins.

We think there is a connection between radically different sensing systems and intelligence within our own species. We see a value in neurodiversity, in brains working slightly differently. We are trying to explore understanding radically different sensing systems in the hopes that it will uncover a new understanding of different forms of intelligence.

One problem with our definition of intelligence is that we compare it narrowly to human abilities. We are very limited in understanding a very different sort of intelligence. Which is why we are trying to create embodied wearable prosthetics, to allow people to fully comprehend the different intelligence in a more visceral way.

First, we sense, then we respond to those senses. The combination of that builds intelligence. There is actually one theory for how we built the ability to speak and think. That we made sounds, then heard them, then compared what we heard with what we had planned to sound like. And this circular series of events of sensing and acting led to the ability to speak and think.

In considering how differently a human senses from an octopus, it's important to consider how differently we sense from each other. To celebrate and value neurodiversity we sent a tool kit of hackable whisker packs to several groups of people, including visually impaired performers, dyspraxics and makers, believing they would have a unique perspective on tactility. We left out how they should use or modify the whiskers open ended as we wanted to encourage user led ambiguous play and co-design.

3. DESIGN PROCESS

The design process is built from gathering insights from Umwelt experts. This includes scientists and researchers who are looking at mycelium networks, octopus and forests. As well as people who spend a lot of time caring for or around these beings and believe that they have got to 'know' the lived experience through observing them.

We have also gathered insights from our own observations and secondary research. We then perform a design synthesis phase where we collect together these insights in order to create prosthetics that can potentially map onto the human body.

We then build prosthetics in order to pinpoint key aspects of each kingdom, questioning what is the central aspect of how this kingdom exchanges or communicates or senses? Choosing one aspect, we explore how that can be experienced on the human body.

We then test these prosthetics. From the testing phase, we then reflect and iterate the prototypes. Finally, we discuss our findings back with the experts in order to maximise the benefits of the iteration process.

The purpose of the prototypes is to produce a physical manifestation of the research. Some prosthetics become science communication tools or at least manifestations of a philosophical idea, when we can only make something that allows us to imagine the other world of the creature. Part of our research is playing with this line between science and philosophy. This is a way to tangibly explore what more we can know about these worlds through prosthetics and our limited senses.

4. METHODOLOGY

Our methodology consists of the following component parts:

(i) **Interviews:** We gathered a group of umwelt experts including: Jay Cousins, Sue Thomas and David Satori

(ii) **Literature Review:** A literature review of existing Umwelt Hacking attempts was conducted including David Abrams Becoming Animal (Abram 2011), Charles Foster, Being a Beast, where he lives as a badger, a deer, an otter, an urban fox and attempts even a swift. (Foster 2016) and Marshmallow laser feast, in the eyes of the animal.

(iii) **Design synthesis:** Bringing together insights gathered from research and

observations of Forests, mycelium and octopus to design prototypes

(iv) **Design matrix's:** Mapping out insights together to find similarities and differences.

(v) **Kingdom centred design:** Considering our designs from that kingdom's perspective: What is important to that kingdom, what are the kingdom's struggles and joys. Mapping out the wider reality of the Create prototype prosthetics to experiment with finding ways of sensing more like the Forest / mycelium or octopus

(vi) **Testing:** Test prosthetics with a variety of users (including the neurodiverse)

(vii) **Iterative design:** Iterative cycle of user testing, reflecting on experience and creating new prototypes.

4.1 Play and ambiguous goals

During our sessions we take into consideration the core insights gathered and use them as a theme (e.g. = octopus are very tactile, so tactility becomes a theme of exploration) but we allow play to be the method in which that theme is explored. By having ambiguous goals, we can be open to more radical outcomes.

4.2 Design provocation

Design provocation involves using prototypes, visuals and concepts to stimulate discussion. This is not about validating final concepts but about provoking new insights and sparking new conversations. In a workshop context it also allows for different thinking styles to engage with content in a new way which can open up new ideas and discussions.

4.3 Sample questions for guiding our discussions with the Umwelt experts

- When a slime mould does a maze, how does it make those decisions?
- What can trees sense? (we assume they know where water is, and where light is, is there something else?)
- Do trees sense each other?
- Do trees sense through their roots?
- Do trees have other senses?
- Is it always an individual tree, or can a group of trees sense as one?
- Can trees communicate? (this can be in an abstract way, separate from how we consider communication)
- Are trees intelligent? (can be in an alternative way from what we consider human intelligence)
- Mycelium and Octopus' – Same questions but we are also interested in when is it one organism or a group? Or is the individual and a group the same thing?

5. THE OCTOPUS

One of the most interesting things we discovered is that they are the only creatures to develop a radically different brain from our own. Octopus have a central brain, and a brain in each tentacle. This means they have top down and localised control. So, they tell each tentacle to do something, but also watch it go. Each tentacle also has chemical control; it emits a chemical that repels their other tentacles to avoid tangling. Their skin can also feel, taste, sense light and change colour (Figure 1). This research made us realise that sensation and tactility is paramount to an octopus which led to the design of the whisker's prosthesis.

The octopus's brain and nervous system is a very unique expression of evolution. All other creatures who we consider intelligent, and have a complex brain are very close on the evolutionary tree, where our closest ancestors to an octopus are a tiny flat worm.

Camouflage is also a big theme. They are so aware of the colours and textures in their environment that they can, for example, easily become a piece of seaweed. Mischief and craft are another big theme. There are tons of examples of octopus mischief. Also creating their own tools for hiding.

Another thing that is interesting to consider is why they are not more intelligent. One thing to take into account is that the octopus cannot exactly reflect on how they change. Humans improve their speech by hearing what they say and reflecting on what their plan was. We believe that an octopus doesn't have the ability to do this. They do not grow very old which also stops them from developing more. They do learn from others, but they are often solo creatures with no parents.

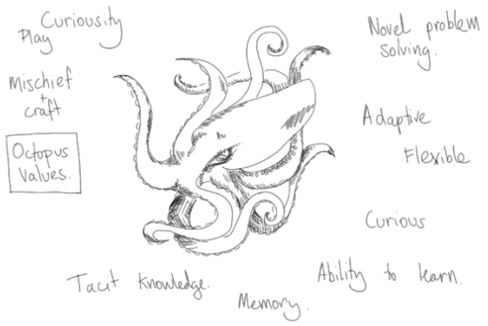

Figure 1: *Parameters of Octopus intelligence*

6. INTERVIEWS WITH UMWELT EXPERTS

David Satori: I think that feeling what it's like to be a tree or a fungus actually requires us to first learn to feel more human by conscientiously putting ourselves in our natural evolutionary context (nature). When we learn about cultures across the world that live a lot closer to nature, we see an extraordinary capacity to empathise and "know" what it means to be other creatures, and that's especially true of people who hunt for a living.

That's why the art of tracking is now starting to become a popular practice in bushcraft and mindfulness courses. When you can read nature and decipher the stories of why things look the way they do, you can slip into the memory trace of the animals that left the tracks. The same is true for intuitive herbalists, and probably true for indigenous mycologists (but I've never heard of such a person!).

It's like becoming familiar with a friend – you have to spend a lot of time with them to "really" know who they are, and it could take years before you know the developmental situations that shaped them to be who they are, and only then can you put yourself in their shoes.

I think we really need to spend more time with organisms that aren't just humans, and more time in the woods just thinking about the lives of all the plants and fungi around you. I spent some time in the Yorkshire Moors when I came across a St George's mushroom growing from the root system of an old oak. At once it reminded me of my childhood when I'd go searching for mushrooms and the feelings that brought up in me when I found them. So I sat next to it and just observed it and imagined all the complex nutrient exchange that are happening between the mushroom's mycelium and the root tips of the tree, what it feels like to have a thirst for glucose, nitrogen, phosphorus, water, and after a few minutes I was like "ah, I get it".

But that aha moment quickly disappears once you're back at home. Our nature-disconnected society makes us feel like we're unable to understand trees or fungi, but just like an unused muscle withers away, our senses do too if we don't train them. Technologies can be really useful for bringing us closer to nature (like, a thermos is an amazing tool for helping me to stay outside for longer in the winter), but we can only use it if we have a good foundational nature connection, otherwise prosthetics can risk alienating us even more.

Sue Thomas: David Abrams wrote "A genuinely ecological approach does not work to attain a mentally envisioned future, but strives to enter, ever more deeply, into the sensorial present". (Abram 2011).

I'm not sure how far I agree with the first part, but the second part certainly strikes a chord because, sadly, this is often what I do not do when I'm in nature. I still find it hard just to 'be' without slipping into intellectualising, and in terms of the question of this paper, I wonder whether any deliberate attempt to sense like a Forest or Mycelium network is doomed to failure simply because it is deliberate and therefore the antithesis of the purpose?

Of course, we don't know how 'deliberate' a tree's life might be, if at all. I live near the New Forest and often go there, but David Abram's observation has made me realise that I spend too much time being active there and not enough time simply standing or sitting still quietly while what is above and below me goes about its business.

7. UMWELT PROSTHETICS

We explored ways of amplifying the sensation of the skin. We imagined that by giving our human body parts amplified tactility and more sensation through whiskers each arm becomes more kinaesthetically intelligent, sentient, and curious and can experience the world more like an octopus.

7.1 Wind whiskers

These leaf-like whiskers augment the body with whiskers that move and pull at the skin with the movement of the wind. This allows the wearer to have a new experience of sensing the wind and allows observers to see the flow of wind around them.

7.2 Whisker whiskers

This suit gives the body amplified tactility and sensation through whiskers. This experiment is about becoming more somatic and valuing the kinaesthetic understanding of the forest. By giving our human body parts amplified tactility and more sensation through whiskers it suggests ways that humans may become more kinaesthetically intelligent, sentient, and curious. It considers ways we can manipulate and rewire our sense of spatial navigation by amplifying what our skin feels.

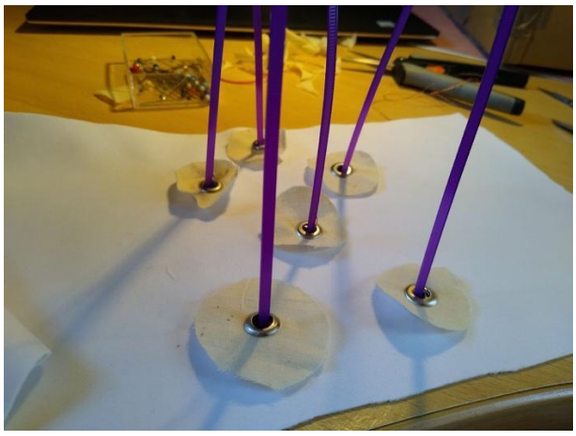

Figure 2: *Whisker whiskers*

Figure 3: *Whisker whiskers*

Figure 4: *Wind whiskers*

Figure 5: *Wind whiskers toolkit*

Figure 6: *Wind whiskers*

Figure 7: *Wind whiskers*

My favourite hack was this person who connected all the whiskers together to make the sensation travel up her body; as she played with a whisker on her hand, she would feel it up her arm.

> I had to really focus, creating quite a mindful experience. I found myself rediscovering common objects in a new way. Felt like a whole new sensation.
>
> I noticed textures on things I had never noticed before, the whiskers heighten my sense of when something was near.
>
> The whiskers could illustrate to an audience what I'm sensing and feeling, and how I am perceiving my space.
>
> It forced me to make time for exploring how my body felt. A mindful time where I felt new sensations.

Figure 8: *Whisker suit*

Figure 8: *Whisker suit*

8. UMWELT HACKING FRAMEWORK

Another part of the research is to create an Umwelt Hacking Framework where we generate guidelines for other Umwelt hackers which they can then apply to their own investigations. A sample of these guidelines include:

- Observe what are the forests paying attention to, what are the fungi paying attention to?
- Sit and observe and imagine all the complex nutrient exchanges (Engage the imagination – like an unused muscle it withers away, our senses do too if we don't train and activate them)
- Mushrooms can't move and neither can trees – maybe we need to bury ourselves?
- Use prosthetics to disable the human (so you can't pick up your phone, disable time)

> We can only achieve umwelt hacking if we have a good foundational nature connection, otherwise prosthetics can risk alienating us even more. I try and use my hands before the spade. We have a different awareness of fibre when we have to rip, tear, chomp and chew. So, perhaps it's about tool reduction before augmentation.
>
> – Jay Cousins.
>
> When you can read nature and decipher the stories of why things look the way they do, you can slip into the memory trace of the animals that left the tracks. The same is true for intuitive herbalists, and probably true for indigenous mycologists.
> – David Satori.

9. SUMMARY

We understand that we cannot claim through our prosthetics that we are sensing "like them" but we hope we are one step closer to sensing a new form of intelligence.

10. FUTURE WORK

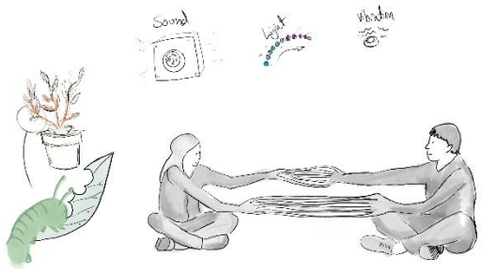

Figure 9: *Future prosthetic design based on plant responding to danger*

We are designing our next round of prosthetics. First, we are considering mapping onto the body the response plants have to being nibbled. Some plants will actually send a chemical signal through their leaves to make themselves toxic, this signal can also be passed on to other plants. This prosthetic (Figure 9) will see two to eight people wearing gloves with long extended fingers which will connect to the next person. Signals will be passed from person to person along the gloves by light, sound or vibration.

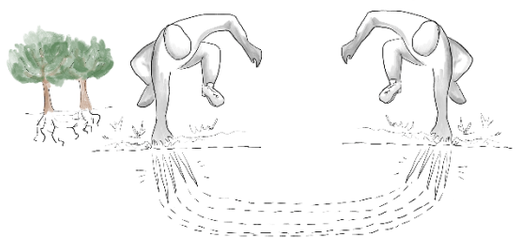

Figure 10: *Future prosthetic design based on experiencing being a forest in a mycelium network*

Another prosthetic (Figure 10) considers what it would be like to be a tree within the mycelium network. In this design each person would put their hand into a ground embedded prosthetic.

When both people have their hand inside the prosthetic it will simulate a mycelium network by sending and receiving signals potentially in the form of vibrations. We will experiment sending different sorts of signals through the prosthetic to represent different nutrients. The research and testing will reveal what signals we end up using.

In future iterations we will focus on considering the human at different scales. e.g. one human being, one fungus, or another human being a whole mycelium network. We would like to consider what it would be like to be one cell in the human body.

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Art(NET)work: Visualising interconnected artwork data in VR

Anne Tsjornaja
University of Greenwich
London, UK
anja.726@gmail.com

Jonathan Weinel
University of Greenwich
London, UK
J.R.Weinel@greenwich.ac.uk

Martyn Broadhead
University of Greenwich
London, UK
M.P.Broadhead@greenwich.ac.uk

1. INTRODUCTION

As the technology progresses, VR becomes more widespread and finds uses outside of gaming. One of these applications is virtual museums (Alatrash et al. 2021). As it has been shown that active participation with art pieces plays an important role in audience experience (Passebois Ducros & Euzéby 2021), virtual museums are gaining popularity all over the world. This makes VR a great tool that is potentially able to increase audience engagement with art, increasing its outreach.

Museums all over the world have launched virtual tours, allowing audiences to wander through representations of gallery spaces and take a closer look at famous art pieces. In addition to digital representations of real museums, there are also completely digital museums that are accessible only through VR. However, these completely virtual museums rarely take advantage of their freedom from the restrictions of the physical world.

Harnessing the potential of VR in this domain, we present Art(NET)work: an application able to visualise data in an interactive and immersive manner that can provide a much richer and more intuitive understanding of the data (Figure 1).

Figure 1: *View from inside the Art(NET)work.*

2. DATASET

For this demonstration of our data visualisation approach in VR, we are using the Open Dataset from the National Gallery of Art (Washington, DC) (National Gallery of Art 2021). It contains more than 130,000 artworks, however for this project, we focus our attention on the 'painting' category, which has 3767 entries (Figure 2).

In addition to images of the paintings, we make use of the following attributes, provided by the dataset: artist name, artist country, year, medium, and dimensions. Each of these attributes can be used to sort and filter the artworks within the VR gallery.

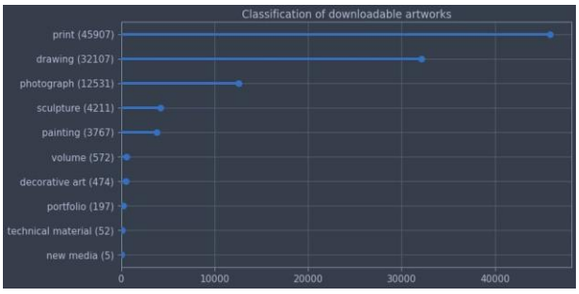

Figure 2: *Classification of artworks from dataset.*

Figure 3*: Art(NET)work presents artworks as nodes, where similar groupings are provided by elastic forces.*

3. VR APPLICATION

This VR application's goal is to provide a different way to explore famous artworks and investigate various properties (author, year, medium) and connections between them, which may give insights not currently available. Once inside the Art(NET)work the user can explore the environment by moving around. The user also has the ability to expand any of the nodes to view the full painting.

This application presents data as a graph network where each node represents a painting (Figure 3). The connections between the nodes simulate an elastic force proportional to the similarity of the artworks. These attraction forces are counteracted by a magnetic repulsive force. As a result, the user may expect the nodes that are physically close to each other to share one or more properties.

4. SUMMARY

Art(NET)work is a prototype application, providing an interactive visualisation of artwork date in VR. This an ongoing project and it is anticipated that new parameters will be added to manipulate the connection between artworks in the future. Improvements to the user interface may also be made following user testing and feedback, which is currently ongoing. It is intended that this project will help to forge new approaches for visualising artwork data, and the data visualisation framework being explored is also generalisable, as it could be applied to other sources of data.

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Cyberdelics: Context engineering psychedelics for altered traits

Carl Hayden Smith
Ravensbourne University London
6 Penrose Way, Greenwich Peninsula,
London SE10 0EW
UK
c.smith@rave.ac.uk

Melissa Warner
University of Melbourne
Swinburne University
Psychedelic Research in Science & Medicine (PRISM)
Australia
melissa@prism.org.au

'Cyberdelics' and 'Cyberdelic Psychotherapy' have the potential to offer greater precision in modulating and entraining therapeutic psychedelic experiences. Both Psychedelics and Cyberdelics have the potential to immerse users in enriched sensory landscapes; both have been studied as mediums of transformative experience and both have been used as aids to help recovery from mental illness. Psychedelic-assisted therapy (PAT) is a promising and unique therapeutic modality with a focus on disrupting entrenched ways of thinking, feeling and perceiving. Both Psychedelics and Cyberdelics do not guarantee positive change, they are experiential medicines and technologies that may provide a 'window of plasticity' that can be utilised within a therapeutic process, towards wellbeing and personal growth. To frame and catalyse both spheres, Context engineering (CE) involves the deliberate re-structuring of experience to enhance and expand perception and cognition. CE gives us new abilities and control over our senses providing us with a new type of self and societal exploration. CE considers the broad spectrum of what augmentation can do but also highlights the dangers of focusing solely on the medicine or the technology. Our hypothesis is that the use of context-engineered virtual and augmented environments can assist in stabilising the insights precipitated through the psychedelic-assisted therapy process. We propose a variety of game mechanics or mechanisms by which cyberdelics may help modulate or optimise psychedelic-assisted therapy, supported by context engineering, positive psychology, mindfulness, transformative experience design, and the gamification of wellbeing. If utilised wisely, cyberdelics may provide an enhanced learning environment for the development of set, setting and skills to support psychedelic-assisted therapy from preparation, acute-experience to integration.

Psychedelics. Cyberdelics. Virtual reality. Metacognition. Transformative experience design.

1. INTRODUCTION

Psychedelic experiences and Cyberdelic experiences (which consist of immersive virtual reality (VR) and extended reality (XR) components) open up the experiencer to new possibilities and avenues of being. It was Alan Watts a prolific Zen philosopher who in "Work as Play", makes the suggestion that "playing through" all aspects of life, is the game to outwit the fear of death and make the mundane a game of artful being (Watts 1995). Timothy Leary proposed that Cyberdelics were the way to "democratise the cyberscreen politics of the future"… and reprogram the mind (Leary et al. 1994). Timothy Leary was a polarising pioneer of the early psychedelic movement; it could be said that his involvement with the counter-culture blurred the lines between the goals of the movement, the personal, and the early scientific inquiry into the potential of psychedelics as therapeutic substances, originally coining the phrase "turn on, tune in, drop out". However, after witnessing the political backlash towards psychedelics in the 70s as well as the rise of personal computing led Leary to self-correct the phrase in the 80s to "turn on tune in, boot up", in recognition of the opportunities of a more sustainable engagement with the zeitgeist of our time.

2. PSYCHEDELIC ASSISTED THERAPY

Psychedelic assisted therapy (PAT) is intrinsically a unique therapeutic modality. In a supportive setting, psychedelics can disrupt entrenched ways of thinking, feeling and perceiving (Nutt et al. 2020). Fundamentally, psychedelics are an experiential therapy. Healing is mediated through the interaction between pharmacology, neurology, psychology and the context of the psychedelic therapeutic space. Several contributing physiological, neurological and pharmacological mechanisms have been studied to unveil the mechanisms of psychedelics (Nichols et al. 2017, Carhart-Harris & Friston 2019). These theories aim to define the mechanisms behind what has been described as psychedelics ability to open a 'window of plasticity', within a therapeutic process to instantiate, and develop the mindset and skills for psychological wellbeing within individuals.

2.1 Transformative Experience: Set, setting and skill

It has been established that psychedelics facilitate a particular variety of experience which, within a therapeutic context, facilitate positive personal change at an increased rate, compared to other therapies (Johnson 2018). In this way, psychedelics may be described as catalysts for transformative experience.

Within the framework of PAT, the terms transformative experience, peak experience and mystical experience have been used interchangeably in the literature (Roseman 2018). Peak or transformative experiences were described by psychologist Abraham Maslow as "rare, exciting, oceanic, deeply moving exhilarating, elevating experiences that generate an advanced form of perceiving reality" (Maslow 1964). Maslow observed that those who experience more frequent peak or transformative experiences are more frequently, self-actualisers, the pinnacle stage of his 'hierarchy of needs'.

PAT may evoke experiences of personal transformation rapidly through the activation of 'pivotal mental states' (Brouwer & Carhart-Harris 2021). Pivotal mental states are adaptive and responsive states that are transiently comprised of hyper-plastic mind and brain states, with exceptional potential for mediating psychological transformation. They are an inherent property of the human brain itself, which have served an important evolutionary function, to provide a framework for psychological transformation when actual or perceived environmental pressures demand this.

Figure 1: *Pivotal Mental States may facilitate transformation between state to stage change*

However, for change to be sustained and stabilised over time it is likely to require the development of metacognitive skills through a consistent and resourcing therapeutic-alliance (Ardito et al. 2011) and, personal contemplative practices (Khoury 2017). While careful attention to 'set and setting' is fundamental in the PAT process, we propose that systems to support the development of 'skills' is essential in the navigation and stabilisation of transformative experience.

3. CYBERDELICS

Cyberdelic technologies allow us to create novel altered states of consciousness. Cyberdelics do not attempt to replicate psychedelic effects but instead provide an entirely new set of (complementary) experiences to add to the overall toolkit. With the explosion of hybrid and perceptual XR technologies such as VR, AR and MR (Mixed Reality), we are able to extend the possible realities we can reach. The ability to alter our senses and design new senses provides us with a whole new tool-set for metaprogramming and self-transformation.

We will review and discuss a range of cyberdelic experiences that can help support psychedelic therapy whilst focusing on the following framing questions: How adaptable is our perception? How can artificial senses be used to access a wider our perception of reality? How can we develop and use these emerging mixed reality technologies to generate new forms of experience and induce non-ordinary states of consciousness? Can we engineer non-dual awareness through technological interventions? How can we use Cyberdelics to break out of the prisons of our own perception? How can hybrid technological devices, of often-prosthetic alienation, help us to reconnect to ourselves and to the surrounding environment?

4. SUPPORTING FRAMEWORKS

4.1 Gamification of Wellbeing

In games, individuals engage in intrinsically motivated behaviour that may also provide cognitive, emotional, health and social benefit (Johnson et al. 2019). Games are playful experiences that entertain the player(s). Gamification can be defined as the "use of game design elements in non-game contexts" such as in

learning or at work (Deterding et al. 2011). Several examples now exist where games are utilised to elicit behavioural change in a naturally rewarding or 'autotelic' way to support psychological wellbeing. XR applications exist for the treatment of OCD, anxiety disorders (Linder et al. 2017), diabetes dietary control (Theng 2015), and development of mindfulness (Döllinger 2021).

On a psychological level, gamification brings to attention concepts of motivation vs control, behaving as a 'player' of the game rather at the whim of conditioned responses (Husley 2019). Evidence suggests gamification can have a positive impact for health and wellbeing related interventions (Johnson et al. 2019).

4.2 Context Engineering

In this paper we propose a variety of game mechanics or mechanisms by which cyberdelics may help modulate or optimise psychedelic-assisted therapy. The intention is that this modulation and optimisation results in lasting change (altered traits). Context Engineering (CE) is a framework that helps support this process. (Smith 2014; 2016)

CE is a trend being seen across multiple disciplines where we are moving from a 'content consuming' economy to a 'context creating' economy. For example, we are no longer satisfied with simply watching media (cinema), we now want to enter the media itself (metaverse). CE is a new paradigm where we focus less on transforming content (as the primary activity), and more on how we can make our own perception the 'content'.

CE will give us new abilities, control over our senses and the ability to develop new forms of perception, providing us with a new type of self and societal exploration. CE is concerned with the technological extension of the human condition through the investigation of the ethical use of emerging technologies to enhance our biological and cognitive capacities.

CE enables us to change the context ourselves: this could be through i) augmenting our senses, adjusting the way we see, the way we hear, the way we smell, the way we touch or the way we taste. Or ii) by generating entirely new senses such as a time sense or a north sense, where we can permanently locate the sense of north, thereby improving our sense of direction as a whole.

CE forms the basis of Cyberdelic design because when we develop Cyberdelics we want to deeply imprint on our capacities for transformation. We propose that CE systems and skillsets are essential in the navigation and stabilisation of transformative experience. We also carefully design the pre and post contexts of the Cyberdelic experience including the set (body and mind) and the setting (environment).

5. CYBERDELIC GAME MECHANISMS

5.1 Awe

The experience of 'stimuli that are vast, that transcend current frames of reference, and that require new schemata to accommodate what is being perceived' with the identification of one as a 'small self' in relation to something larger than oneself (Gandy et al. 2020). The phenomena of being in relationship with something more expansive and complex than oneself. "Whereas the beautiful is limited, the sublime is limitless, so that the mind in the presence of the sublime, attempting to imagine what it cannot, has pain in the failure but pleasure in contemplating the immensity of the attempt" (Kant 1781).

When something is experienced as being much larger than the self's ordinary frame of reference this leads to a "need to accommodate", to assimilate an experience into current mental structures (Weger & Wagermann 2018). The need to adjust cognitive schemas to successfully assimilate a new experience is associated with an expansion of one's frame of reference. This results in a sense of gratitude, humility, sense of connection and perception of beauty. However, a failure to accommodate can produce confronting, terrifying and upsetting feelings. These aspects awe reflect in the fragility of the psychedelic experience as a state of great potential, context and skill dependant.

5.2 Flow

Flow is a state of genuine satisfaction, in absorption with an activity, particularly a creative process (Csikszentmihalyi 2013). Flow states are described as "optimal experience" and an organisation of mind that is "strong, alert, in effortless control, unselfconscious." Csikszentmihalyi theory of flow suggests that happiness does not simply happen, "optimal experience is thus something that we make happen". It can be prepared for and cultivated by setting challenges that are sufficiently demanding without being too complex for the players abilities.

5.3 Closed Loop Systems

Adam Gazzaley defines a '**closed**-**loop system**' as one where (Ziegler et al. 2019):

- an individual is challenged by an intervention,

- the influence the challenge has on the individual is recorded in real-time,
- Data then immediately updates the dynamic to be more effective in eliciting the desired response.

Closed loop systems have been successfully utilised in video game systems for neuro-cognitive optimisation for the treatment of poor executive function, such as ADHD (Mishra et al. 2020).

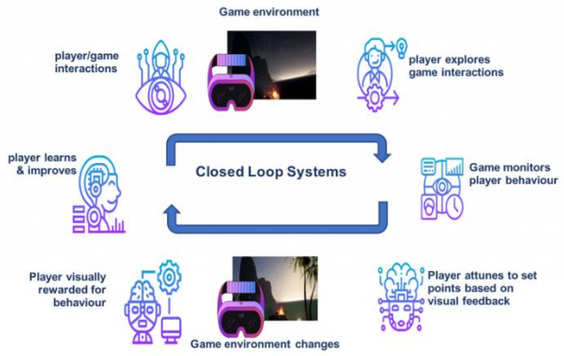

Figure 2: *Closed Loop Systems. A dynamic feedback loop, guiding outcomes: The approach of the Neuroscape lab run by Adam Gazzaley at UCSF.*

5.4 Mindfulness in XR

By implementing mindfulness programs in XR, instructions and guidance are provided in an immersive virtual world. These worlds have a range of options that can be tailored to the individuals needs based on their personal development interests. Biofeedback, the data communicated between biosensors, visual feedback through the game and conscious awareness enables the potential for 'quantified mindfulness' (Döllinger et al. 2021). Set points from breath rate, movement, gaze, HRV, GSR and EEG can be tracked to personalise the experience to the user's state. There are a variety of metacognitive stances that experiences could benefit from eliciting and exploring with appropriate audio guidance and visual reward.

5.4.1. Embodied vs Disembodied cognition
Interception is the perception of sensations from inside the body and includes the perception of physical sensations such as heartbeat, respiration, satiety, as well as bodily emotions (Farb et al. 2015). Interceptive capacity is intrinsic to one's sense of embodiment, motivation, and wellbeing. Virtual Environments8may bring attention to the breath through visualisation of the breath in the game world. Virtual experiences can also support shifts in perspective, for example, transitioning from having a virtual body to being disembodied may facilitate experiences of 'self transcendence'.

5.4.2. Acceptance vs Autonomy
Shifts between having the ability to modulate the game world to succumbing to circumstances outside of the player's control.

5.4.3. Focus vs Distraction
Creation of periods of focus while modulating the levels of distraction to entrain attention and concentration.

5.4.4. Compassion and Reflexivity
Narrative framing is used to model metacognitive stances of mature adult development. Scripted meditations invite the player to explore their cognitive landscape with greater awareness and precision.

5.4.5. Tolerance of Ambiguity and Uncertainty
The creation and exploration of paradoxical situations to help entrain a comfort in discomfort.

5.4.6. Relaxation vs Activation
Bringing interoceptive awareness to the transition between relaxation, fight-flight responses, selective attention and the navigation between.

6. EXAMPLES OF RELEVANT CYBERDELICS

6.1 Richie's plank experience

Richie's Plank Experience is a VR psychological thriller. The participant enters a hotel, goes in a lift in order to reach the 80th floor. When the lift door opens a cityscape and a single plank pointing outwards towards the city is revealed. The object of the game is to walk the plank. It is astonishing how due to the fact that the brain/body is so immersed in the experience how hard it is to convince yourself to actually walk on the virtual plank. The crucial game mechanic that relates to how this could help with the preparation, or an integration of psychedelics is that when you fall off the plank you drop to your virtual death and experience a 'white out'. This experience of 'embodied letting go' is particularly invaluable for the preparation of the 5meoDMT experience. In order to avoid trauma whilst ingesting this powerful entheogenic medicine it is fundamentally crucial to let go. Letting go is not a cognitive process but a very much embodied one so it is very important to practise this over and over again. Richie's Plank Experience is therefore a fantastic example of a context-engineered cyberdelic environment that can help assist in stabilising the set and setting before a psychedelic-assisted therapy process begins.

6.2 Isness

Isness is a platform which is powered by a VR physics engine created by David Glowacki. Isness is a guided ritual, using additional hardware in the form of the mi.mu gloves (Freire 2010) to enable a game mechanism within the experience – the gloves are used to create a mudra: a mudra connects the universal consciousness (via the thumb) with the individual consciousness (via the finger). When the connection is made a point of light is generated within the darkness of the VR space. Other points of light start to appear in the space as other people in the space also create their mudras. Everyone then becomes connected through these points via the real time physics engine. This is an incredible way of dissolving boundaries and temporarily stripping away the 'grand illusion'.

One of the most powerful parts of the ritual is when you are encouraged to move into the ground, suddenly this mirror world is revealed which makes tangible the power and potential of this technology for transformation beyond the physical constraints of the real world.

During the pandemic, Isness Distributed (Isness D) was developed in order to explore what could be achieved without having a single physical space.

The advantage of being 'beyond the physical' was the ability to step inside other people's energy 'cloud forms', and then begin to merge those energies. This was very transformative, the sensation of not needing a physical space, but feeling like you were still in one. This ability to merge your energy with other participants qualifies as another Cyberdelic game mechanism. This is because it was reported to have regularly produced an altered state of consciousness (ASC) in the participants. (Glowacki 2020)

The next iteration of the project was called 'Numadelic Flow' which was less ritualised and more free-flowing, combining in this instance Qigong with breathwork. This iteration enabled the ability to share their breathing process with another person using 3D generated Buckminster Fuller 'buckyballs'.
(Glowacki et al. 2021)

6.3 Eternal Return

Eternal Return is a composite work that uses VR technology, physical objects and performance to explore reality as speculative fiction. The work is composed of a reality matrix consisting of three intertwined digital replicas of historical buildings that are hyper-connected to sculptures and fragmented objects…. the piece unfolds as a series of encounters with physical and mental objects, augmented by the analogue touch of an unseen performer and digital code. (Lundahl & Seitl 2019).

This is one of the most powerfully transformative Cyberdelics which can be revealed by the number of game mechanics at work within the experience:

i) **Point-cloud interaction:** a matrix grid houses an object archive made of lidar scans. This object archive creates portals to other realities. Objects can also dissolve, implode or 'spurt out a room'. For example, a piano workshop emerges out of a teacup, the workshop spirals around the visitor until they are fully immersed inside it. This has a powerful transformative effect in its unique phenomenology which is very unlikely to have been experienced before, (apart from maybe during a psychedelic experience).

ii) **Double Consciousness:** When the participant touches the interior in the virtual space, they simultaneously touch the 'sculptural abstractions' in the physical world. The physical and virtual are designed to conflict with each other, in the sense that it is ultimately up to the participants in which realm they are most present.

iii) **Virtual proxy:** participants interact through the analogue touch of unseen performers. (Machon 2019).

iv) **Freedom of movement:** this is a powerfully reinforcing mechanism as freedom of movement is related to the duration of the participants curiosity and attention.

v) **Uncertainty / Ambiguity principle:** While objects appear visually complete within the virtual space, if the participant tries to pick up certain objects then they will feel incomplete physically.

vi) **Trust:** trust is measured by the resonance between the performer and the participant, this game mechanic is made tangible whilst exploring the 'connection to' and the 'influence over' an environment.

vii) **Engaging multiple senses:** scent is also used to create the presence of water and soil.

viii) **Non-dual experience:** Another key transformative moment is achieved by dissolving physical boundaries to generate a non-dual experience. In order to achieve this the participant is instructed to touch a solid wall in the physical world and is at the same time

made to be convinced that it is made up by millions of subatomic particles in the virtual space. Participants are then asked to walk straight through the wall, the illusion is achieved because in the physical space the wall is simply moved out of the way but the point cloud of subatomic particles remains. The visual effect is again reinforced as the friction of passing through the wall is both felt and heard through a vibration.

ix) **Death literacy:** At a crucial point in the Eternal Return journey, participants are led towards a decomposing body (which appears to be a lidar scan of a forensic scene, which Scanlab specialise in). (Shaw 2014). The participant is then asked to crawl inside the corpse of light. What happens next is arguably the most powerful part of the entire experience as the participant then 'drops' around 10 meters (virtually) into the floor stimulating both an OBE and a rapid descent into the underworld which is a motif of all the ancient mystery schools practises.

Cyberdelic content producers	**Delivery Context**		
	Direct to consumer	*Clinical Research*	*Retreat /Exhibit*
RICHIE'S PLANK EXPERIENCE	*X*		
ISNESS		*X*	*X*
NEUROSCAPE		*X*	
*T**REE HUGGER***			*X*
ETERNAL RETURN			*X*

***Table 1**: Cyberdelics Experiences*

6.4 Tree Hugger

Tree Hugger is an early piece by the Marshmallow Laser Feast VR studio. This exhibition took place in a large warehouse with a foam structure in the middle of the space. Whilst wearing a VR headset the foam structure is transformed into a lidar scan of a giant sequoia tree. The participant is then able to explore the inner systems of the tree from the perspective of the water.

Some game mechanisms involved in Tree hugger include:

Perspective shifting: One of our human conditions is that we often lose perspective. Humans have a habit of thinking that we are at the top of the food chain and as a result this causes all kinds of problems. We are fundamentally disconnected from the nested ecology around us, not knowing the smaller scale of what we depend on. We therefore don't see the consequences of our actions. When you have the experience of being water moving through a tree you have the potential for a lasting change in perspective.

Time distortion: this powerful game mechanic is enacted when your individual sense of time is placed in relation to the temporality of a 3000-year-old sequoia tree.

Merging inside and outside: You can be outside the tree hearing the rain fall or inside the tree watching the inner mechanisms come to life.

Out of Body Experience (OBE): As the water moves through the tree the participant starts to rise off the virtual ground, inducing an immediate OBE.

Perception shifting: By showing you the world beyond your senses and changing your perceptions of reality you may come back transformed.

Macroscopic vision: Experiencing a forest in which you could fly and yet be able to explore every detail with a form of infinite zoom.

Behaviour shifting: Having a connection to a place that is fast disappearing might enable local and global behaviour change.

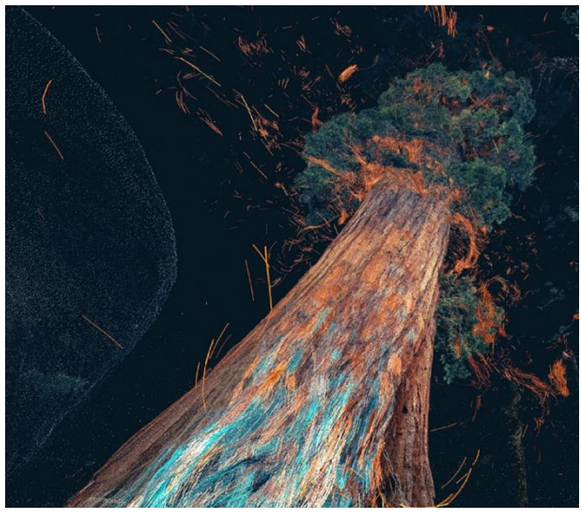

***Figure 3**: Experiencing a giant sequoia tree from the perspective of the water running through it.*

7. CONCLUSION

Our hypothesis is that the use of context-engineered virtual and augmented environments

can assist in stabilising the insights precipitated through the psychedelic-assisted therapy process. Psychedelics are experiential, and thus contextual medicines, and there is much to learn about what contextual factors and psychological incentives will lead to the best outcomes in each individual patient (Carhart-Harris 2018). By combining Psychedelics with Cyberdelics we can perhaps support optimal outcomes and minimise adverse or unsettling experiences. Tailored immersive environments may increase psychological safety and facilitate exploration. This could be achieved through the 'awe-inspiring' experience of visual immersion, the specificity of modular 'in-game' experiences and the ability to customise aspects of the environment to an individual's physiology and personal perspective.

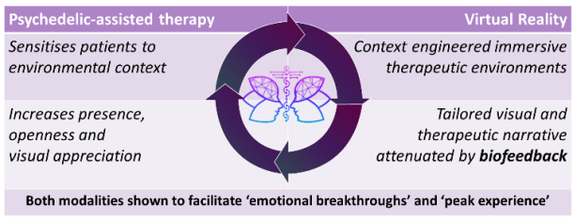

Figure 2: *Synergies between PAT and VR*

A recent paper on VR as a moderator of psychedelic-assisted psychotherapy concluded:

> "We suggest virtual reality (VR) as a full-spectrum tool able to capitalise on and catalyse the innately therapeutic aspects of the psychedelic experience, such as detachment from familiar reality, alteration of self-experience, augmentation of sensory perception and induction of mystical-type experiences." (Sekula 2022)

However, Sekula and his team do not seem to also address the risk factors.

Cyberdelics in themselves are already a powerful mind-altering tool way before they are combined with Psychedelics. Two powerful mind-altering tools combined needs a lot of investigation. We don't have a firm grasp on either of them individually yet.

A major risk is do these interventions whether Cyberdelic or Psychedelic aid the imagination or atrophy it? We need to be very careful not to degrade the role of the imagination i.e. we do not replace imagination with computer animation.

Finally, another concern is designing for positive transformation in the first place. Transformation design is a problematic activity because arguably you can provide the means for transformation but not the subjective experience of the transformation itself.

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Connecting Colour-Coding and Hand-Drawn Interfaces for Study Resources, Menu and Navigation to Enrich Student Learning Experience

Joskaudė Pakalkaitė
University of Exeter
The Old Library, Prince of Wales Road,
Exeter EX4 4SB, UK
j.pakalkaite@exeter.ac.uk

1. INTRODUCTION

In this short paper, I present the theory behind a new innovative concept of connecting colour coding and hand-drawn interfaces, as well as their application in the development of the navigation system of the Study Skills Online Resources section. Next, I present the methods used to develop the navigation system. Finally, I explore the significance of this design and provide future directions for further study.

2. THEORY

According to Keyes, colours distract users and create barriers to identifying information, when badly misused in user interfaces (1993). This study concludes that colour-coding is an effective solution because it helps students to categorize the instructional visual stimuli and process information (Lamberski and Dwyer 1983). My previous study explores the benefits of hand-drawn interfaces for the users and suggests that hand-drawn interfaces can potentially provide better online experiences (Pakalkaitė 2021). In this project, I connected the two User Interface elements of colour-coding and hand-drawn interfaces, to create a navigation system. Through this I aimed to enrich the student online learning experience for the Study Skills Online Resources section.

3. METHODS

After the expert review was completed, the brief was to create fifteen icons for each section on the Study Skills Online Resources menu page as well as enhance navigation for the students (Rosenzweig 2015). Firstly, I identified the colours from the University of Exeter's brand book, which will be used for each icon. Secondly, I drew the icons with a pencil to represent each category and then traced the outlines with a fine line marker over the pencil drawings (see Figure 1). Thirdly, I scanned the images and altered them on Photoshop. Then I used the Web AIM Contrast Checker online tool to identify whether a white or black outline is more accessible for each of the fifteen background colours from the University's brand book.

Figure 1: *One of the scans of the unpolished hand-drawn icons.*

4. RESULTS

The final fifteen hand-drawn icon images were then uploaded into the main menu on the Study Resources (see Figure 2). Additionally, each of the fifteen sections had their own left-side navigation menu with small squares next to each one. Those menus inherited the colour of the main menu (see Figure 3). This project illustrates how colour-coding and hand-drawn interfaces can be created and successfully implemented for better menu online navigation and a 'warmer' digital experience.

Figure 2: *Screenshot of Study Resources menu.*

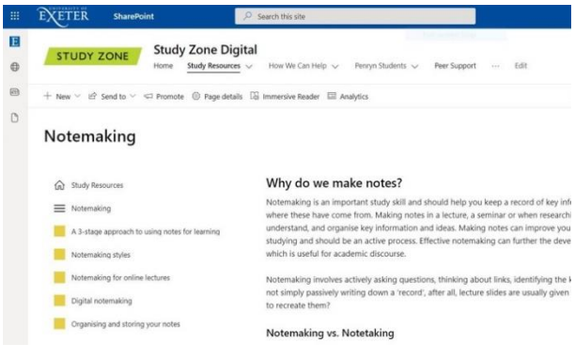

Figure 3: *Screenshot of Note making menu within Study Resources section.*

5. IMPLICATIONS

Before starting to work on this project, I researched the equivalent of the Study Skills resources websites of 20 other research universities and explored the design of them. I identified four types of design: text-based link menu, same colour-coded sections with the type on it, photographs used as images accompanied with the text below and hand-drawn illustration with coloured background accompanied with the text below them (however these did not have all separate colour bur rather the same colour sections). However, I did not see the same use of colour-coding and hand-drawn elements as in our project. Nevertheless, this sample size was too small to categorically state that no other institutions have utilised this concept. Although the theory suggests this method produces a better user experience, data would need to be collected and analysed to support this. This concept could potentially be useful, not only for the user, but also as a new methodology for the designers who create navigation menus for Study Skills resources.

6. CONCLUSION AND NEXT STEPS

This project illustrates how colour-coding and hand-drawn interfaces can be created and successfully implemented for better menu online navigation. I hope this will potentially enrich the student online learning experience at the University of Exeter, when using the Study Resources section. This also potentially shows an innovative way of designing menus in a context of Study Skills resources. To establish this, I need and plan to collect the data from other universities' Study Skills Resources menus and feedback from students.

7. ACKNOWLEDGMENTS

I would like to thank my colleagues Dr Caitlin Kight, Kellie Cox and Jennie Fox for their invaluable help, support and feedback during this project as well as for implementing the icons and colours on the Study Resources pages.

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Design and Development Considerations for Serious Games to Assist in the Rehabilitation of Patients with Back Pain: An overview

Tahmeena Javaid Adeel
Bournemouth University
Poole, UK
tadeel@bournemouth.ac.uk

Rehan Zia
Bournemouth University
Poole, UK
rzia@bournemouth.ac.uk

Oleg Fryazinov
Bournemouth University
Poole, UK
Ofryazinov@bournemouth.ac.uk

1. INTRODUCTION

In this paper, we present a survey of serious games for rehabilitation of back pain. We explore the need and context for the serious games for back pain rehabilitation and compare key features of contemporary games in this category. This study sets the context for future PhD research work in creating the games for patients with back pain.

Physical therapy is the branch of medicine that deals with the rehabilitation of patients using specific exercise interventions to help patients improve or regain physical abilities (Davis 2021). Rehabilitation can help reduce pain and improve mobility in patients with injuries or musculoskeletal conditions. However, some patients may lack the motivation for physiotherapy or they may lose interest mid-intervention. Maintaining patient engagement in physiotherapy becomes a challenging task health care professionals. Patient motivation is a key factor in rehabilitation success and the challenge is to ensure patient motivation and engagement remains high. Digital games can provide a fun and engaging experience and game technology, in combination with other ICT technologies, can applied to a broad range of fields including healthcare (Göbel et al. 2010).

Serious games refer to digital games where the primary function is not just entertainment but to achieve at least one additional goal such as learning or health related (Dörner et al. 2016).

2. CONTEXT

Physical rehabilitation is a useful way of treating various back pain conditions. Conventional physical rehabilitation such as physiotherapy is useful but have various limitations for the patients as well as health care providers. For the former, there can be issues around motivation, fixed appointment times, travel implications and long course of intervention. For the latter, there are issues around missed appointments as well as financial, workload and expertise implications (Bonnechère et al. 2016). Unsupervised exercises that may end up worsening the condition (Liao et al. 2020).

It is a proven fact that serious games-based learning has a positive effect on making changes in health-related behaviour (Göbel et al. 2010). Serious games have found many applications in health particularly in rehabilitation of patients who have suffered injuries or stroke. Rehabilitation using games has been utilised for the treatment of stroke, injuries, trauma, spinal pain, neurological pain and arthritis. Some commercial games have also been used for rehabilitation purposes and with limited success.

There are three key rules that remain the same for rehabilitation games; firstly, the game should be fun to play and enjoyable in order to keep the level of motivation and engagement in patients high. Secondly the game should be customisable to allow for specific exercises for the respective needs of the patient. Lastly, there needs to be a measure of assessment to record and document the patient's performance (GestureTek 2016).

One factor that plays a key role in player motivation is the player's own imagination that builds upon the fantasy world of the game and keeps them engaged with the game and help break the monotony of routine exercise (Van Der Spek et al. 2014).

***Table 1**: Summary of studies on back pain rehabilitation*

Age range	***Input /output***	***Game type***	***Body part movement***	***Clinical/lab or home setting***	***Reference***
18-60	*12 camera Vicon Bonita Motion Monitor software, unity, head mounted display, hand controllers, Vive™ trackers system,*	*Matchality, Fishality, and Dodgeality*	*Lumbar flexion excursions*	*Lab*	*(France and Thomas, 2018)*
18-65	*Wireless motion sensor (Valedo®Pro, Hocoma)*	*Guiding a caterpillar Guiding a fish*	*Lumbar spine and pelvis, pelvic tilt*	*Clinical*	*(Matheve et al., 2020)*
40	*Microsoft Kinect Xbox*	*Soccer ball*	*Lumbosacral movement*		*(Mbada et al., 2019)*
18-25	*Pro-Kin system PK 252 N Techno body*	*Shooting game*	*Trunk movements (flexion, extension and lateral flexion)*	*Clinical*	*(Nambi et al., 2021)*

3. EXPLORATION METHOD

In this study, our focus has been on three key terms “rehabilitation”, “game” and “back pain”. Papers selected are from year 2018-2021. A total of 106 papers were found. After taking out repeat titles and unrelated papers, sixteen papers were selected. We used an exclusion/inclusion criterion based on age range of 18-60, and limiting one paper per author team. Based on these criteria, four papers were identified.

Following elements were considered during the study: a) medium used for input & output, b) game type, c) player movement/motion (localised or full body), and d) clinical or home setting. Details of the study are given in Table 1.

4. CONCLUSION

Using games for physical rehabilitation of back pain is an active area of research. Current studies are mostly based on non-specific chronic back pain.

Important considerations for serious games for patient rehabilitation are economy, motivation, time and reduction in therapist needed for each session.

In our survey, we did not find any adverse effects of the games made particularly for back pain being identified.

With the advancement of gaming technology and rise in serious games for rehabilitation, the aesthetics of games and game design is also gaining importance. Our future work will be focussed on using escapism and fantasy to drive the game aesthetic and game play in order to increase and enhance patient motivation and engagement in serious games development for rehabilitation of patients with lower back pain.

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Majority World Diasporas

Daniella Chukwuezi
Independent
London, UK
daniellachukwuezi@gmail.com

1. INTRODUCTION

Leading British sociologist Stuart Hall states "language is the privileged medium in which we make sense of things, in which meaning is produced and exchanged" (1982). It is made up of signs and symbols that come together to create meaning in culture, meanings that have been given to them by culture makers. Words have connotations that people, as participants of a culture, use as a frame of reference in their understanding of the world. To challenge ideological injustices in culture, the language of a society must be challenged as well.

The term "Majority World" is a term coined in the 90s by Bangladeshi photographer and social activist Shahidul Alam (2008). The term is being increasingly used to describe countries in Asia, Africa and South America. It is a more accurate representation of the part of the world that is often referred to as "third world," "developing world," or "minority ethnic." Alam describes the terms as "[challenging] the West's rhetoric of democracy" and represents the region in a more humanitarian and positive way.

2. IDEOLOGICAL CODES

Amongst other ideologically loaded terms used to describe the majority World region is "the Global south." This term on face-value should refer to the geographical part of the world south of the equator, however it is used to refer to describe what the Western World describes and represents as the socio-economically "less developed" nations, nations that were formally colonised.

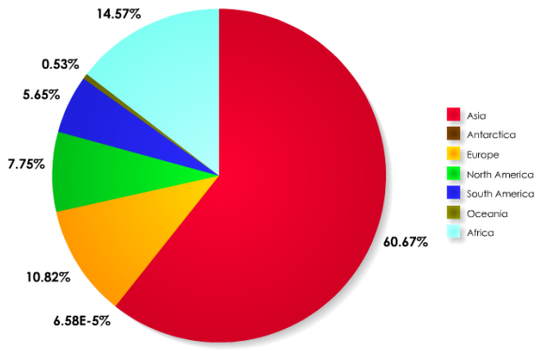

Figure 1: *World Population by continent*

As a word, "south" connotes being at the bottom. The fact that Australia and New Zealand, two predominately white countries at the very bottom of the globe, are not included in the global south term suggests that non-whiteness is linked with subordination; "Ethnic minority" connotes cultural insignificance, even though those groups factually make up over 80% of the world's population; "People of colour" groups and positions non-white identities as the antithesis of whiteness, rather than identities in their own right.

In February 2022 when Russian president Vladimir Putin invaded Ukraine, media outlets were quick to describe the conflict as an attack on a "civilised" society as opposed to the wars that happen in countries assumed to be less civilised. Countries like Syria, Palestine, Afghanistan, places in the Majority World where their populations are black and brown people.

Stuart Hall argues that medias and their technologies play a much more active role in the reproduction of 'reality' – of ideology – than simply mirroring the culture they exist in. He says,

> "Representation is a very different notion from that of reflection. It implies the active work of selecting and presenting, of structuring and shaping; not merely the transmitting of an already existing meaning, but the more active labour of making things mean."

This representation can affect how a society views conflict and tragedy in different situations, where one people's suffering is regarded as more important than another because of the race of a majority of its population.

3. CONCLUSION

This paper is not written to imply that there is some sort of linguistic conspiracy with aims to marginalise groups of people, but rather to highlight the ideological codes imbued within our everyday language and to advocate for a shift in the culture. A lot of the language we use when describing 82.5% of the World's population is often rooted in outdated colonial and imperialist histories. The world has changed, and it is time the language changes with it and better represent, with more accuracy, the nature of global society. Actions need to be taken to redress unequal structures, language is a powerful tool exposing and rectifying present social practices. Using the term Majority World Diasporas is a way one can promote the humanity of black and brown people, identities historically marginalised, while challenging the colonial and archaic ideologies embedded in our globalised culture.

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A Fallen Line of Marble Drums

David Penny
Artist/Researcher
Manchester Metropolitan University
School of Digital Arts, Manchester, UK
d.penny@mmu.ac.uk

1. INTRODUCTION

A Fallen Line of Marble Drums is an on-going interdisciplinary artistic research project developed within the context of expanded approaches to photographic art practice (Soutter 2016). It considers alternative ways of working with photography, photographs and notions of the photographic, incorporating digital technologies, such as 3D scanning, digital animation and 3D printing as research methods to make artworks for exhibition output.

The focus of the project is located in Athens, Greece and specifically a ruined Corinthian column that is part of the ancient Temple of the Olympian Zeus, a popular tourist site in the centre of the city. The column was destroyed in a little documented hurricane in 1852, knocked over by the storm and remaining to this day, with its drums stacked in a line along the ground.

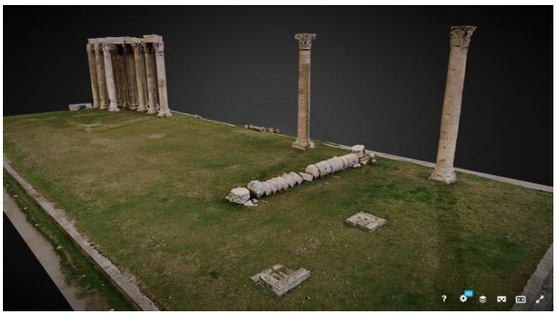

Figure 1: *Temple of Olympian Zeus, 3D Model (Panomedia)*

The column's form, material and the event of the storm is used as an starting point within the research methodology. Digital and analogue artworks have unfolded from this point of departure, and address a contemporary extreme weather event that by chance occurred the day I first visited the site.

This paper discusses two works made for the project: A digital animation installation titled *Pentelic Scarves,* modelled around a snapshot photograph made in Athens and a set of digitally constructed images titled *Firma* (*collage)* made through layering of LiDAR scans, captured across multiple sites relevant to the project.

2. ATTICA WILDFIRES JULY 23RD 2018

The timing of my visit to the temple site on the 23rd July of 2018, coincided with a tragic day in the Attica region. Around the city that day, sudden and erratic winds swept through the streets. I was also aware of an ominous purple/pink haze dominating the sky, which remained for the duration of the day. I subsequently learned of the wildfires that had rapidly swept through the coastal town of Mati, killing over 100 people. The fires had started on Mount Penteli (also the origin of the Marble quarried for the temple).

Following this terrible event and within the context of my experiments with digital imaging systems, I sought to develop works that would make a connection between the event of the storm in 1852 and the event of the wildfires in 2018. These distinct events are placed alongside one another in order to ask asks how such a practice might contribute to interdisciplinary dialogues around the increase in frequency of extreme weather events, brought about through the global climate crisis. The project looks back to the event of the storm in 1852 and proposes the ruins of the Corinthian column, as symbolic representation of the threats posed by increasing extreme weather events.

2.1 Pentelic Scarves

Pentelic Scarves, is a 3-screen digital animation installation modelled on a photograph and experiences of that day in Athens. An image of a tourist display stand of silk scarves was unintentionally made using the iPhone Live Photo

mode, later revealing the scarves caught flowing in the winds.

Figure 2: *Display stand, still frame from LivePhoto Loop (by author)*

Reflecting upon the image and learning of the impact of the winds and consequent fires, led to the creation of the animation. The 3D modelling software Maya was used to create a virtual version of the stand. Individual textured cloth elements, rendered using directional wind simulation, create interactive collision events between the modelled scarves.

The piece is made as memorial of that day. Presented in the gallery on screens, supported by a custom scaffold structure and free standing in open space its appearance resembles a cenotaph. The installation offers a contemplative experience, the sombre animation can be moved around and viewed from different angles. It is orchestrated so synchronised interactions of scarves across screens can just about be perceived, as the animation plays through, creating an uncanny affect.

2.2 Expanding the photographic

The work is a digital visualisation and evidently not a photograph, in the way the snapshot it is derived from is. However, the work could be considered to be photographic, in that retains qualities or characteristics that are found in a traditional photograph. Modelling software is increasingly used in commercial still-life work, taking the place of images made in “real” studios, with the resulting images perceived and unquestioned by their audience as photographs. Pentelic Scarves not only iconically resembles its referent display stand but also looks back and recollect a memory of the day’s events.

“Memory, in the abstract, exists somewhere between the particular subject who remembers, and the particular object that stimulates the remembrance” (Kember 2008).

Figure 3: *Pentelic Scarves, still frame and installation view (by author)*

2.3 3D Collage

Further processes utilising LiDAR scanning technology have been developed to make digital collage works. These experimental pieces synthesise 3D scans of landscape elements in the different locations, relevant to the project, combining them within a singular virtual environment using the software Blender. The results, rendered and framed through a virtual camera, are impossible, imaginative landscapes. Images across the series reveal differing levels of digital noise or glitches produced through the process, though on first glance appear as apparently traditional perspectival photographic images. The locations used to capture 3D scans are the Temple of Zeus, the ancient quarry site at mount Penteli and the town of Mati.

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EVA London 2022: Keynote summaries

Ann Borda
(editor)
University of Melbourne, Australia
University College London, UK
https://www.ucl.ac.uk/information-studies/ann-borda
aborda@unimelb.edu.au

Natasha Trotman
Artist in Residence
Somerset House, Studio 48
London, UK
https://www.rca.ac.uk/more/staff/natasha_trotman/
enquiries@natashatrotman.com

Charlie Gere
Lancaster Institute for the Contemporary Arts
Lancaster University, UK
https://www.lancaster.ac.uk/lica/about/people/charlie-gere
c.gere@lancaster.ac.uk

Birgitta Hosea
University for the Creative Arts
Farnham, UK
http://www.birgittahosea.co.uk
birgitta.hosea@uca.ac.uk

Anastasiia Gliebova
Institute of Law, Technology and Innovation, Kharkiv, Ukraine
V-Art http://v-art.digital
anastasiia.gliebova@v-art.digital

Olga Simson
Yaroslav the Wise National Law University, Kharkiv, Ukraine
V-Art http://v-art.digital
Olga.simson@v-art.digital

This paper includes summaries of keynote presentations and short biographies of the keynote speakers at the EVA London 2022 Conference on *Electronic Visualisation and the Arts*. EVA London broadly covers digital art and culture, attracting an international audience, interdisciplinary speakers, and practitioners.

Digital art. Digital copyright. Digital culture. Inclusive design. Metaverse. Neurodiversity. Non-Fungible Tokens (NFTs). Social media and warfare.

1. INTRODUCTION

This paper highlights summaries of invited keynote talks and backgrounds of the keynote speakers attending the EVA London 2022 Conference, as in the 2021 Conference (Bowen et al. 2021). EVA London takes place annually, originally starting in 1990 (Bowen 2020; Hemsley 2013). EVA London 2022 is a hybrid conference of online and in-person participation. The Conference is broadly based on digital culture with a special emphasis on digital art (Boiano et al. 2019; Borda & Bowen 2019; Giannini & Bowen 2019).

The keynote speakers have a diverse set of backgrounds, both in theory and practice, presenting on leading-edge themes and discourse in their talks.

This year's keynote talks address topical intersections of digital art, curatorship, and digital cultural networks, including neurodiversity and inclusive design, social media and warfare in the Ukraine, curating digital art in China, the metaverse and non-fungible tokens (NFTs), among other compelling topics.

2. KEYNOTE SUMMARIES

NATASHA TROTMAN

Design Council Expert Specialist,
Artist in Residence, Somerset House, Studio 48, London

Hybrid ND imaginaries: Exploring the (un)official discourse across neurodiversity, equality and belonging

This discussion explores the official and unofficial neurodivergent (ND) discourse, offerings, and outputs, including neurodiversity, equality, belonging and the emerging multi-modal continuum of access and belonging based on two projects.

Project 1: Design and the Mind:
Design and The Mind (DtM). This project, a partnership between the Wellcome Trust and the Royal College of Arts Helen Hamlyn Centre, used an inclusive design approach that places visitors, their needs, requirements and lived experiences at the core of the Wellcome Hub. Inclusive Design takes into account a broad range of human diversity regarding ability, communication, culture, gender, age and other variances of human experiences and conditions.

The project investigated how this can have a positive impact on the Hub community ranging from the space to residents, visitors and the broader organisation through a cascade effect. This approach helps further the progress of integrating a neurodiversity paradigm and a barriers approach being introduced through Design and The Mind at the Hub. This helps to encourage social cohesion, co-design and new neurodiverse spaces for wider and new Wellcome Collection audiences with outcomes such as The Wellcome Hub Engagement Recipes and Companion, a co-programmed Neurodiversity 5-day Hub programme, and participatory Wellcome Collection Reading Room event Once more with Feeling with DtM's Citizen Researchers. Also, Inclusive multi-modal Toolkits for the Wellcome Collection Hub and Wellcome Collection.

***Figures 1–4**: Wellcome Trust. Trotman, N. and The Institute of Imagination (2018). 5-day Programme: Our Brains and Us.*

Project 2: Neuro-Mnemonic:
Neuro-Mnemonic (NM) is an umbrella project building on the learnings, insights and enduring questions that emerged from previous Inclusive multi-modal umbrella project Tangible Statistics Linguistics, NM explores how an Equalities Design approach that considers horizontal, vertical and diagonal needs across an x, y, and z-axis can positively impact those multiply marginalised using a rights-based approach through moving beyond and illuminating non-typical frames of reference. Neuro-Mnemonic illuminates unofficial discourse across neurodiversity and neurodivergence, interrogating systems through a kaleidoscope of multiply marginalised lenses' spanning themes that emerged during the pandemic. The articulated output is a 360-degree interacting (abstract) immersive video of ND Polyvocality, aiming to illuminate unheard, overlooked voices and move towards hybrid rights-based futures and a more profound sense of belonging for the marginalised in a post-pandemic world. This work has been exhibited with organisations such as The National Gallery NGX, Art in Flux, The Royal Borough of Kensington and Chelsea's Art Week and Ars Electronica.

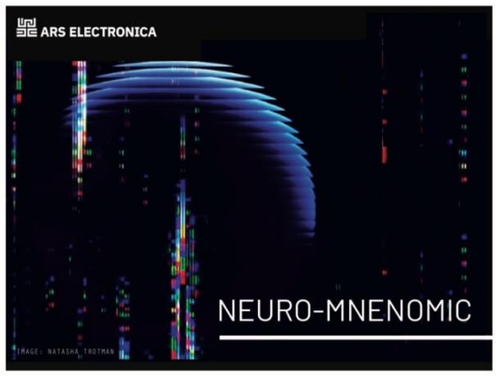

***Figure 5:** Trotman, N. Still/image (2021), Project, Neuro-Mnemonic, Ars Electronica.*

Biography:
Natasha Trotman MA(RCA), MCSD, FRSA, FIEDP is an Equalities Designer and Researcher whose practice explores extending the frontiers of knowledge around mental difference, which includes non-typical bodyminds, ways of being and marginalised experiences, in addition to reframing normative notions of equality, equity, diversity, and inclusion. This is done via an intersectional design lens, spanning multi-modal interactions, place-shaping, investigative play, and policy design for varied audiences, participants, and organisations. A fellow of the Royal Society of the Arts, a member of the Chartered Society of Designers, and a fellow of the Institute of Equality, Diversity Practitioners. Natasha is currently a Design Expert Specialist for the Design Council and a consultant for Wellcome, one of the Developers for Wellcome Collections Social Justice Curriculum; she also sits on the WCIT Advisory panel and is an artist in residence at Somerset House studio 48 in London.

CHARLIE GERE
Lancaster University, UK

From 4Chan to Kyiv: Social Media, Politics War

The Guardian newspaper described the Russia-Ukraine conflict as the 'first TikTok war'. At one level such a description appears trivialising in the context of the extreme suffering and devastation wrought by Putin's troops on Ukraine. However, it also points to the degree to which this war is seen through and even determined by social media.

I start with Walter Benjamin's observation in *The Work of Art in the Age of Mechanical Reproduction*

that 'The destructiveness of war furnishes proof that society has not been mature enough to incorporate technology as its organ, that technology has not been sufficiently developed to cope with the elemental forces of society'. Over the last twenty years or so we have been trying to understand the massive social and cultural changes wrought by our new digital networking technologies, in particular the simultaneous development of the smartphone and social media. As events such as Brexit and Trump have shown these developments have had profound and destabilising effects on society and politics. The use of social media as a means of achieving this destabilisation is part of the Russian concept of hybrid warfare, the so-called Gerasimov Doctrine, and as such can be seen as successful. However, one aspect of the invasion of Ukraine has been the considerable brilliance with which President Volodymyr Zelinsky has used Instagram, Twitter, and Telegram. In my presentation I examine the relation between politics and social media from 4Chan to Kyiv.

Biography:
Charlie Gere is Professor of Media Theory and History at Lancaster Institute for the Contemporary Arts at Lancaster University and previously, director of research at the Institute for Cultural Research at The University of Lancaster. Previously, Professor Gere was lecturer in digital art history in the School of History of Art, Film and Visual Media at Birkbeck College for seven years, where he ran the MA Digital Art History. He chairs the group Computers and the History of Art (CHArt) and is director of the AHRB-funded Computer Arts, Contexts, Histories etc. project at Birkbeck. He is author of several books and articles on new media art, art and technology, continental philosophy and technology. His main research interest is in the cultural effects and meanings of technology and media, particularly in relation to post-conceptual art and philosophy.

BIRGITTA HOSEA
University for the Creative Arts, UK

Fission: Curating Digital Art

In this presentation, Birgitta Hosea presents documentation from the *Fission* exhibition that she co-curated with Zhang Xiaotao and Li Fei and outlines the curatorial process. Commissioned for Guizhou Municipal Museum, the exhibition features the work of 46 artists from around the world working with digital media and is spread across 2200 m^2 of exhibition space. Bringing together this range of artists raises the problematic linking of very different artworks with very different approaches and thought processes through their common usage of a particular medium.

The central metaphor of the exhibition is the process of *fission*. In biology, fission is a natural way for algae, bacteria and other single celled organisms to reproduce. The tightly coiled DNA in the cell first elongates before splitting into two. The cell then itself splits forming two identical daughter cells. Nuclear fission, on the other hand, rarely happens in nature. It is a primarily unnatural, human procedure driven by technology. In this case, the splitting of atoms is induced by bombarding the unstable nucleus of a uranium cell with neutrons, which 'excites' it until it bursts emitting non-identical particles and large amounts of energy. This is a form of transmutation as the resulting fragments are not the same element as the parent atom. These fragments can trigger a chain reaction in nearby particles.

Fission, the exhibition, compares this nuclear chain reaction with the proliferation of multiple forms of digital art. Just as bombarding a uranium cell with neutrons causes an explosion of different particles and the release of energy, digital art can be seen as an unstable concept that has exploded into many different forms since the invention of digital technology and re-animated art itself. As it takes so many different forms, in the 2020s how can we even begin to conceptualise 'digital art'?

***Figure 6**: Fission exhibition poster.*

Biography:
Birgitta Hosea is Professor of Moving Image at the University for the Creative Arts. She is an artist, animator and curator working with expanded animation and performance drawing. Professor Hosea has previously taught in Azerbaijan, USA, Romania, Austria, Sweden and China, where she is a Visiting Professor at Chengdu University. She was previously Head of Animation at the Royal College of Art (2016-8), Course Director of MA Character Animation (2000-15) and Research Leader in Performance (2011-4) at Central Saint Martins. In 2017 she co-curated Boundary Crossings, an artists' residency and exhibition of animated installation art, with artist Rose Bond at PNCA, Portland, Oregon, USA. As part of her teaching practice, she has worked on public engagement projects with major museums and archives such as the National Gallery, ENO, London Transport Museum, National Theatre Archives, RSC, the Wellcome Digital Collection and the V&A, which involved using animation to reinterpret and recontextualise artefacts from the collections in order to make them accessible to different audiences.

ANASTASIIA GLIEBOVA
CEO and co-founder of V-Art

Co-author: Olga Simson,
CSO and co-founder of V-Art

Digitalization of art: current state and future prospects

During 2021 the world faced the challenges of COVID-19 pandemic, and in 2022 it built a new reality in which humanity has become more dependent on digital communications. Just in the first three months of the pandemic, the business was forced to make a leap to digitalization that would otherwise take about five years (Mckinsey 2020). So in 2022, technological development has become even more rapid. As entrepreneur and futurist Peter Diamandis says, the next ten years will be more significant in terms of scientific progress than a whole previous century (Corbyn 2020):

> In the next 10 years, we're going to reinvent every industry. And that's getting even faster because the number of people with access to technology is increasing. First of all, it can be expected that the world will move into virtuality at a faster pace (Peter Diamandis interview, *The Guardian*, 25 January 2020)

In October 2021, the Facebook founder, Mark Zuckerberg, announced that he plans to focus on creating the "Metaverse", a hypothetical model of the Internet that supports 3D virtual environments and can be accessed using virtual reality (VR) and augmented reality (AR) headsets. Such elements of the metaverse as digital assets, non-fungible tokens (NFTs), digital homes and virtual persons, that is, avatars, have appeared in the world. In less than one year, more than $400 million has been invested in NFTs and, according to Forbes' estimates, they continue to invest $40 million every month. Sales of both art and collectibles as NFTs have risen from $4.6 million in 2019 to $11.1 billion in 2021. The AR market is projected to grow to $77.0 billion in 2025, with an annual growth rate of 38.1%. The VR market will reach $20.9 billion in 2025, with a compound annual growth rate of 27.9% (Markets & Markets 2020).

Virtualization and digitalization have begun to play an important role on the art scene, but since NFT platforms run on the Web3 decentralised blockchain, sellers are not required to pass any Know Your Customer (KYC) verifications or other audits before they start selling. Many NFT platforms allow you to mint new NFTs for free with a series of simple steps and without any restrictions. Potentially, on many platforms, anyone, even a bot, can create an NFT, even if they don't have the rights to the original content, put it up for sale without having to prove ownership of the original image. While platforms are subject to copyright law, specifically the WIPO Copyright Treaty (WCT) of 1996 and the Digital Millennium Copyright Act (DMCA) of 1998, intellectual property infringements may be difficult to detect, and the fight against this phenomenon will be complicated due to relative anonymity, as well as the ability to use different wallets and pseudonyms.

Due to the misuse of free minting of NFTs, one of the largest NFT platforms, OpenSea (http://opensea.io) temporarily imposed limits on the number of NFTs that could be minted in 2021 (to five collections and 50 items per collection). The reason for this was that more than 80% of the minted images were plagiarised works, fake collections, and spam, which clearly demonstrated the significant scale of this problem on large platforms.

In order to monitor and detect such infringements on behalf of artists and collectors, DeviantArt (http://www.deviantart.com), one of the largest international content platforms for artists, launched DeviantArt Protect in 2021, a new image recognition software that scans public blockchains and third-party marketplaces for potential art infringements in the form of minted NFTs. These measures made it possible to detect infringements on their own platform of around 70 million registered users. Since launching their software in September 2021 to the end of January 2022, they had sent 120,000 infringement alerts to their users, and the number of infringement alerts grew by 30% from September to October, by November to December the monthly growth rate was over 300%, indicating serious problems for the long-term stability of this market.

Even the work of renowned NFT artist, Mike Winkelmann (Beeple), whose collage *Every days: the first 5000 days* sold at Christie's in March for $69.3 million, has been hit by scammers. In April 2001, the hacker Monsieur Personne created copies of Winkelmann's work, with fake NFTs referring to the same data as the original token, and the configuration of their components, identifier, and transaction history also resembled the genuine one, so the fake NFT looked genuine. Thus, Monsieur Personne showed that the uniqueness of the NFT is conditional, and technically nothing prevents the creator of the token or hackers from making copies of it an unlimited number of times. A digital artist known as Mushu Person has also made several identical NFTs from Beeple's artworks and posted them on NFT platforms selling himself as Winkelmann.

If a self-regulating system of blockchain platforms and digital assets is not able to prevent such negative processes, the NFT market will be the focus of attention of state regulation and anti-fraud rules.

Biographies:
Anastasiia Gliebova is CEO and co-founder of the V-Art platform (http://v-art.digital) for digital art assets, founded by Ukrainian ArtTech entrepreneurs, and coordinator of the *Digital Art Observatory* artist-research residency (http://tatchers.art/dao) with *Electric Artefacts* (http://www.electricartefacts.art), and Digital Art therapy Studio projects. Anastasiia is also an Art Digitalization consultant and creative manager with a legal and economic background. She is Partner and Head of Research at the Institute of Law, Technology and Innovation (Kharkiv). Prior to founding *V-Art*, Anastasiia has been working in the field of creative management for 5 years with over 30 projects in her portfolio. She is a speaker at events and conferences on technology in the field of art.

Olga Simson is CSO and co-founder of V-Art. She is a Doctor of Law, associate professor of civil law at the Yaroslav the Wise National Law University and CEO & co-founder of the Institute of Law, Technology and Innovation. Olga has led and consulted over 50 international projects in art and creative industries, published over 120 scientific works. Her clients include European gallerists, artists and collectors. Olga is also an expert for the USAID, EU, EBRD projects on innovation and investment, public-private partnerships, and clusters. In recent years, she has been leading the Creative Law Studios project, launched the School of IT Law and Creative Law at ILTI-School, specializing in the areas of Art Law, Fashion Law, IT Law and Media Law.

3. CONCLUSION

The four EVA London 2022 keynote talks were delivered on each day of the conference from 5–8 July 2022. Further information about the keynotes is available at:

http://www.eva-london.org/eva-london-2022/keynotes/

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