
Interactive Art
with Genetic Moo

Commissioned by the Computer Arts Society (CAS)

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List of contributors

Genetic Moo is an interactive art group, consisting of creative coding couple Nicola Schauerman and Tim Pickup. They have been exhibiting since 2008 in bigger and bigger venues across the UK and occasionally abroad. Sometime in 2026, over 1 million people will have seen their art.

Ernest Edmonds is an artist-researcher who pioneered the field of computational art from the late 1960s. He has taught at Leicester Polytechnic, Loughborough University, the University of Technology Sydney and De Montfort University, where he is Emeritus Professor. In 2017 he received the ACM SIGGRAPH Distinguished Artist Award for Lifetime Achievement in Digital Art and the SIGCHI Lifetime Achievement Award for the Practice of Computer Human Interaction. He continues to exhibit.

Sean Clark is an independent artist, curator, and researcher based in Leicestershire. His artwork explores interaction and connectedness. He is the director of Interact Digital Arts, the curator of the Computer Arts Archive and Chair of the Computer Arts Society. He holds a PhD in Computational Art from De Montfort University.

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My name is **Isaac.** I am 10yrs old. I love to make animations and videos and really want to be an animator or coding artist when I grow up. I am autistic and find school hard but I love art and creating cool stuff that is colourful and unique, just like me 🌈

Rebecca Bell is a Customer Experience Advisor at The Amelia in Tunbridge Wells and a postgraduate student in Curating. With a background in model making and special effects, her work focuses on creating engaging, hands-on exhibition experiences that encourage dialogue and creative participation.

Genetic Moo. *Microworld* at Eckert Art Gallery, Pennsylvania (2020)
Photo Heidi Leitzke

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Genetic Moo. *Microworld@HOME*
Weekly live-broadcast between Mar 2020 and Jan 2021, Margate

0. Introduction / Genetic Moo

We make a small living as interactive artists. There are just two of us – we call ourselves Genetic Moo. We don't sell anything – how can you sell interaction? We don't teach professionally, but we have taught lots of free workshops in the past. So how have we survived? This book will explain how we started, how we kept going, how we made connections and scaled up our practice. You can see it as a self-help book for interactive artists. We will discuss what we think interactive art is for, and why it is the best. You will discover how complex it is, but also how rewarding.

So why a book?

After years of hovering at the edges of the Computer Arts Society, we recently joined its working committee (CASCOM). As soon as we did they asked us to put on a show in the British Computer Society building. They also asked us to write a book as part of a series of guides being developed on different branches of Computer Art. We've not written much before, and pretty quickly we decided we didn't want to write an artist monograph. We wanted to take this opportunity to write something that we would have found useful when we started making interactive art in 2008.

Back then, we had to work everything out as we went along. We built it up step by step into what is now an 'acclaimed' practice, putting on large-scale and long-lasting public shows. Interactive art is complex, you can't just hang it on a wall and walk away. What happens next is what matters most: how people respond. This extra layer of challenge beyond the art-making really excites us.

Our book unfolds as a chain of essays moving from the outside in: from the early days of interactive art, to coming up with ideas, making, producing, maintaining, and finally experiencing this art form today. Each chapter focuses on a stage in the process, written by experts who've played key roles along the way. Our progress would not have been possible without their contributions.

The book also considers the benefits of interactive art and includes some art theory - but not too much. After all, there is little sense in endless talk about interactive art, it needs to be experienced.

So let's dive in.

Our take on interactive art

Roughly speaking, we consider video art as better than painting because it includes time, then we see generative art as better than video because it can change over time, and finally we see interactive art as better than generative art because it can change over time in response to an audience.

interactive art > generative art > time based art > fixed art

When we say better, we mean better at exploring life, because with interactive art, your palette includes elements like time and motion. How can you explore what life is without time and motion? You also have gravity, collisions, chaos, action, agency, cause and effect, consequences, entropy, death, and starvation but also creation, birth, reproduction and evolution. So you can work with all of life — many of these things are hard to get across in paint.

The necessity of collaboration

Although you are now reading our book, you rarely see our personal names in print. We just use the group name Genetic Moo. We tend not to put ourselves front and centre – we're not into that "artist as individual genius" model. To us it's stupid. We work together as a team. Genetic Moo was born through collaboration. Our current practice is built on it; we love to collaborate. And that collaboration goes well beyond us. To be honest it would be very hard to make interactive art without collaboration. It is just too complex. You need people who are experts in coding, graphics, sound, technology, installation and of course interaction. And this is a lot for a single person to deal with. Just like in the film industry, it is not just the director who is important. This book describes a whole ecosystem of people and celebrates their skills. We have selected a few of the hundreds we have worked with as representatives of certain professions.

Pussyfooting

Here's a quote from an essay written in 2005 by Andrew Polaine called *Lowbrow, high art: why big fine art doesn't understand interactivity*:

> "Playful interactive content does not sit well with the ideals of serious commentary, contemplation and the hallowed white walls and respectful silence of the traditional gallery. Making noise, moving around manically and laughing, for example, are usually frowned upon in those spaces and possibly earn the visitor an escort out of the door by security."

Twenty years later and the traditional art world is still pussyfooting around interactive art. It is not yet in their comfort zone. But it's getting better – we're hopeful. As technology changes, the world changes, humans change, and eventually art changes too.

The Van Gogh Experience

There is a new type of exhibition that is spreading around the world like wildfire: experiential and immersive art shows. Typically huge wall to ceiling projections with millions of particles flying around everywhere all at once. Often using dead artists' imagery and mashing the hell out of it.

Like a lot of people we have mixed feelings about these shows. They're great because they bring new people to see art (even if they don't exactly call it art), but we see these shows as too passive and too spectacular. How can something be too spectacular? We love watching pixels moving around. We love bright projections in dark spaces. And experiential art does a lot of that. Outernet in Tottenham Court Road is a good example. You look around and see people looking up at the projections, their jaws dropping, the visuals are awesome. But we want people to get a bit more involved. We want them to get physical. We want them engaged and empowered. We want them to have fun. And this is where interactive art comes in. Interactive art is fun to experience on your own or with others. It is also fun to make. Best of all, it is fun to see people having fun with your art.

That is a lot of fun to consider – where did it all come from?

Ernest Edmonds. *Nineteen* (1968-9) Multimedia relief. 183x145x17 cm.
Photo Jules Lister.

Ernest Edmonds. Exhibition *Networked* at Gazelli Art House London (2025)
Photo Gazelli Art House.

1. I am the Pioneer / Ernest Edmonds

It's a long story that began in 1968 and is not finished yet…

1968 was interesting in many respects, not all of them positive. Both Martin Luther King and Robert Kennedy were assassinated. The Vietnam war and civil rights protests, including riots, were big features of American life. There were widespread protests by workers and students in France. Apollo 8 took the first humans into orbit round the Moon. What is more, I started programming and the 'Cybernetic Serendipity' exhibition was held at London's ICA.

As one of the 1960s pioneers, I integrated computing into my artistic practice, helping to define how software could be used creatively. I had to think beyond the technology that was available at the time, both predicting its future and developing computing itself. I anticipated and realised early examples of interactive and networked art, contributed to the formation of interdisciplinary communities and have continued to develop this work over the following decades. It was not easy in those early days. Even having access to computers was not a simple matter, let alone predicting and working towards their future.

In the late '60s, my art was at a turning point. I was moving from landscape inspired abstractions to formal compositions in the constructivist tradition. I decided to make a large composite relief that summed up my work of the previous decade. This was *Nineteen*, which had 20 parts, each consisting of a separate relief on an equal square base. Finding it hard to identify a satisfying arrangement of the 20 parts I realised that I could write a program that searched for a solution. I was working at Leicester College of Technology and ran my program on the one computer that the college had, a main-frame H200. Programming became part of my art practice. Exploring the implications of this innovation, I worked on a paper about art and computing

with my sculptor friend Stroud Cornock. We presented it at the Computer Graphics 1970 conference (CG70). Its title was "The creative process where the artist is amplified or superseded by the computer". The CG70 paper reviewed the nature of the computer and looked at how its use might develop in the arts. Rather than start with what was at that time going on – mostly using the computer to generate semi-automated versions of what could already be done, such as line drawings — it asked, "What is special about the computer?". "What might become possible that was very difficult before?" There were two main conclusions. Interactive art was the future and technology would extend artists' creativity. The answer to the question implied by the paper's title was "amplified".

I soon became part of a small community that included systems artists as well as those making use of computers. Although the systems artists did not use computers, they often made significant use of algorithms. Such work pointed forward to the significance of software. Around this time I met Malcolm Hughes, one of the founders of the UK's Systems Group, who had obtained a computer for use by his Slade students. Thus I became part of a community of artists either using computers or sympathetic to them. Such sympathy was not widespread in those days and we were somewhat isolated. The artists working in the constructivist tradition provided the only real link with the 'conventional' art world.

Another important event in 1968 was the foundation of the Computer Arts Society (CAS). The CAS community also operated largely separated from the art world but was quite active. In fact, the CG70 paper was in a session organised by CAS. It also set up a section of the associated exhibition. Stroud and I showed **Datapack*, an interactive artwork made to illustrate that paper's argument. It used primitive technology by today's standards, but it provided an engaging interactive experience.

In Leicester in 1970, Stroud organised the "Invention of Problems" symposium and exhibition. This event brought together artists using the new technologies and technologists exploring art. My *Nineteen* was included in the exhibition. The following year, he organised a second such event, where I showed the first *Communications Game* (more on that work shortly). Stephen Willats was one of the participants and he invited me to show my next version

of *Communications Game* in his 1973 Nottingham exhibition 'Cognition and Control'. In the same year, CAS organised 'Computers in the Arts' in the fringe of the Edinburgh Festival.

The relationships between the UK's systems and software artists continued. In the 1980s many of us met under the auspices of Exhibiting Space in London. In essence this was a meeting of systems artists, but I added discussion and an exhibition of computer-based art close to that tradition. It was clear that the systems artists had taught and influenced the growing number of software artists. I celebrated this crossover in 2014 by curating the exhibition 'Automatic Art' at the GV Art Gallery, London, showing work by artists such as Kenneth Martin, Harold Cohen, Jeffrey Steele, Anthony Hill, Susan Tebby, Paul Brown, William Latham and many more. It was a gathering of friends around the concept, and for some the realisation, of computation.

When, in 1970, I had started working on the implications of the CG70 paper, I realised that as well as interacting **with** an artwork, participants could interact with one another **through** a computer-based artwork. This was the start of my making what we now call Net Art. *Communications Game* was my first networked piece, and possibly the first such work. In 1971 it consisted of six booths each with light displays and switches. Perhaps unexpectedly, however, the switches controlled the lights in other booths, not the one the operator was in. Participants communicated with one another across a very low bandwidth. This work was made before the Internet. I built the system with logic circuits and had to wait quite a while before the technology we all use today became available and I could realise my dreams.

As this was going on I became a lecturer in computing: a long story that I will skip. But, how could I make this interesting? As Leicester Polytechnic had just been formed by merging the art and technology colleges, the answer seemed clear: study the support of art and design by computing. Although we knew lots of technical things about computing, when it came to interaction not much was known about the human side of it. Hence, I began my second career as a researcher into human-computer interaction, specialising in supporting human creativity. At the same time I worked on pattern recognition and artificial intelligence, including finding ways of exploiting these things in art.

All this time, my aim has been to explore and develop the relationship between art and computing technology, contributing to both fields.

My bringing together of artists, scientists, technologists and theoreticians has also been an important and productive part of my life. For example, in 1976 I organised a Leicester conference on 'Human and Robot Behaviour' which brought together AI researchers from Edinburgh, Cognitive scientists from Sussex and beyond and artists from the Royal College of Art etc. In a way, this was a precursor to the Creativity and Cognition conference series that we started in the early 1990s and that still runs today.

I have often collaborated. But is collaboration essential to computer-based art? The short answer is no. However, collaboration is nothing new in art. Artists have often run studios with assistants, they frequently collaborate when screen printing or making bronze sculptures etc. The issue is, and always has been, is the artwork essentially a collaborative work or has the artist retained control of the key decisions? Each artist working with computers must choose their own way forward.

I set out on a path that emphasised software and interaction almost 60 years ago but never worked in that way exclusively. I still make paintings and some of my work might be thought to be as close to the systems art movement as to computer art. However, it is in **interaction** that there has been most change over the years. Obviously, technological changes and availability have driven this. To take an example from my own work, the concept of *Communications Game* lives on in my practice, but now I use the Internet and the 'booths' that it first used have become connected interactive nodes, widely separated and mostly in different countries. I pass information and images between the nodes through the Internet. The latest example is *Quantum Tango*, joining London, Vancouver and Baku. The early concept remains and the aesthetic is still essentially abstract, although I have found ways of using images in a more-or-less abstract way. More generally, social media, computer games and many other aspects of our lives have brought interaction with and through computers into everyday life. The future that I envisaged in 1970 is now very much with us. All that time, art has been exploring that future. We are now there. So, what next?

Ernest Edmonds. *Shaping Space* (2012)
Installation: two computers, data projectors, Perspex screens and cameras.
Site Gallery Sheffield. Photo Robert Edmonds.

Genetic Moo. *Globster* at Fire Eye Land, Margate (2021)
Photo Tom Shrapnel

2. I am the Inspiration

This book is a love story - it is about our happiness. At every step we (Genetic Moo: Nicola and Tim) consider what will make us the most happy. And this was true from the start, true as we achieved some success, and true today where we wonder about getting bigger and older. How did our passions and inspirations come together into an interactive art practice? Neither of us set out on that course when we were young and we didn't start Genetic Moo in earnest until we were about 40. Making interactive art was not an option at school or university in the 80s. We shared a love for the technologies of the digital age: home computing and home cinema, video games and electronic music, science fiction and science fact. The internet. We loved how technology could create entire universes to explore and exploit. We wanted to create our own worlds too. But how?

Myron Krueger

From the start we were looking at the work of Myron Krueger, an American computer scientist who really delved into what interactive art was in the 70s, 80s, and 90s with a series of interactive experiments culminating in *Videoplace*. Krueger worked within a university context and had access to large spaces and willing collaborators. He explored what interactivity could be on a human body scale. And he wrote a book about all this in 1982, which he called Artificial Reality. Nowadays, he is seen as a pioneer of both interactive and Virtual Reality art. He also derived various rules of interactivity including his most important one "nothing should happen in an interactive medium unless it is a response to some action by the participant". That's a rule we chewed over a lot but abandoned pretty quickly. Our interactive art is often an interaction with an alien creature and making this creature look and sound life-like or contain life-like behaviours, was important to us. Many of these behaviours would be self-

initiated by the creature perhaps in response to its general mood rather than to what the user was doing. We often include a day/night cycle within the environments we create. Rather than light to dark, we use Red to Green to Blue and the creatures change what they are doing depending on what time of day (or colour of day) it is. So there is a lot going on with or without the audience.

Krueger's technological setup would have cost hundreds of thousands of dollars, using video cameras and green screen and mainframe computers. By 2010, it was possible to explore some of the same ideas for a fraction of the cost. The excitement of being in an artificial space was one we shared with an entire generation growing up surrounded by the miracles of science and technology in the latter part of the 20th century. Krueger's vision was to explore the possibilities of full-body interaction and we're still working though his ideas today. He was our biggest influence and though he won plenty of acclaim at the time including one of the first *Ars Electronica* prizes, his work has been forgotten. Virtual Reality and heavily encumbered interfaces have received much more interest, which for us is a shame. We want our art to be easy to access, open and shared by everybody. We even want it to be doable by anybody. Although we don't Open Source our code (partly because the code is so unique to us, and probably a mess to others), we have delivered over a hundred workshops to thousands of people, demonstrating how easy it is to get started in coding. Continue reading and you too will discover how to make simple interactive art yourself (Case Study 1).

Krueger didn't include code in his book but he did show pictures of people interacting and from these it is possible to analyse what is going on. When Krueger says that his participants were given no instruction we need to add some context. A lot of the time, he was working in academic settings where people were used to being test subjects, some of them were his students who were working on the code with him. They interacted in rooms with large video cameras and lights on tripods, and projection screens. They were probably told to "stand over there and you will see a silhouette of yourself. Play with various objects that appear on the screen." They were told to interact for a certain amount of time and then report back. All of these subtle cues to interaction are not easily achievable within a museum setting which is where we now work. We're not behind the screen. The audience must figure out where to go and

what to do, often in rooms without invigilators. Because of this, we haven't managed the complexity of Krueger's achievements yet, but we are getting closer. By the way, our favourite Krueger piece is called *Critter*, a small animated creature which responds to your silhouette. If you hold your hand out it hops onto it.

Other artists we came across exploring interactive art

Ernest Edmonds of course, Igloo, Boredom Research, Alex May, all of whom have shown at Computer Art Society exhibitions around the UK. Tine Bech and Laura Dekker were looking at combining electronics and play. Then there were acclaimed international artists like Ken Rinaldi, Camille Utterback, Jeffrey Shaw, Steven Rokeby, Scott Snibbe, Sommerer & Mignonneau. We could read about them online and in academic books where interactive art often got a small chapter near the back. There were occasional large UK shows of digital art. There was a memorable one in 2009 at the V&A, *Decode: Digital Design Sensations* which included lots of American artists and lots of pieces made using the Processing language, and some interactive artworks most of which were working most of the time. But everything seemed very distant and isolated. And broken. Digital art was causing difficulties. Back then the technology was more complex and less streamlined. One infamous technological piece in a major museum worked for one day and then never again. Everyone was trying to work out this new medium. There was no clear path to follow.

Different directions

One consideration in our making interactive art was that a) it suited our shared skill set well, and b) not many other people were doing it. When making any type of art we think it is always good to go off in a different direction from everybody else. Perhaps this meant it would take us longer to get there, because the lack of people doing it also meant there was a lack of audiences to see it, and a lack of organisational infrastructure to house it – but we could sense that this was where art was going, whether the powers that be liked it or not. Humans could not resist its pleasures. We also tend to believe, like Kevin Kelly says, that there are various inevitabilities to technology as a whole. Even though nobody is in charge of its course - no government, no scientists, not

even any amount of tech bros - the technology will find its own course. And that course is laid down by principles of getting smaller, lighter, faster, cheaper, more connected, more interactive, and this has been the case throughout our lives. We were lucky to arrive at a time and place (the UK was, and sometimes still is, a hotbed of technical innovation) when computer creativity was becoming available to all.

Essence

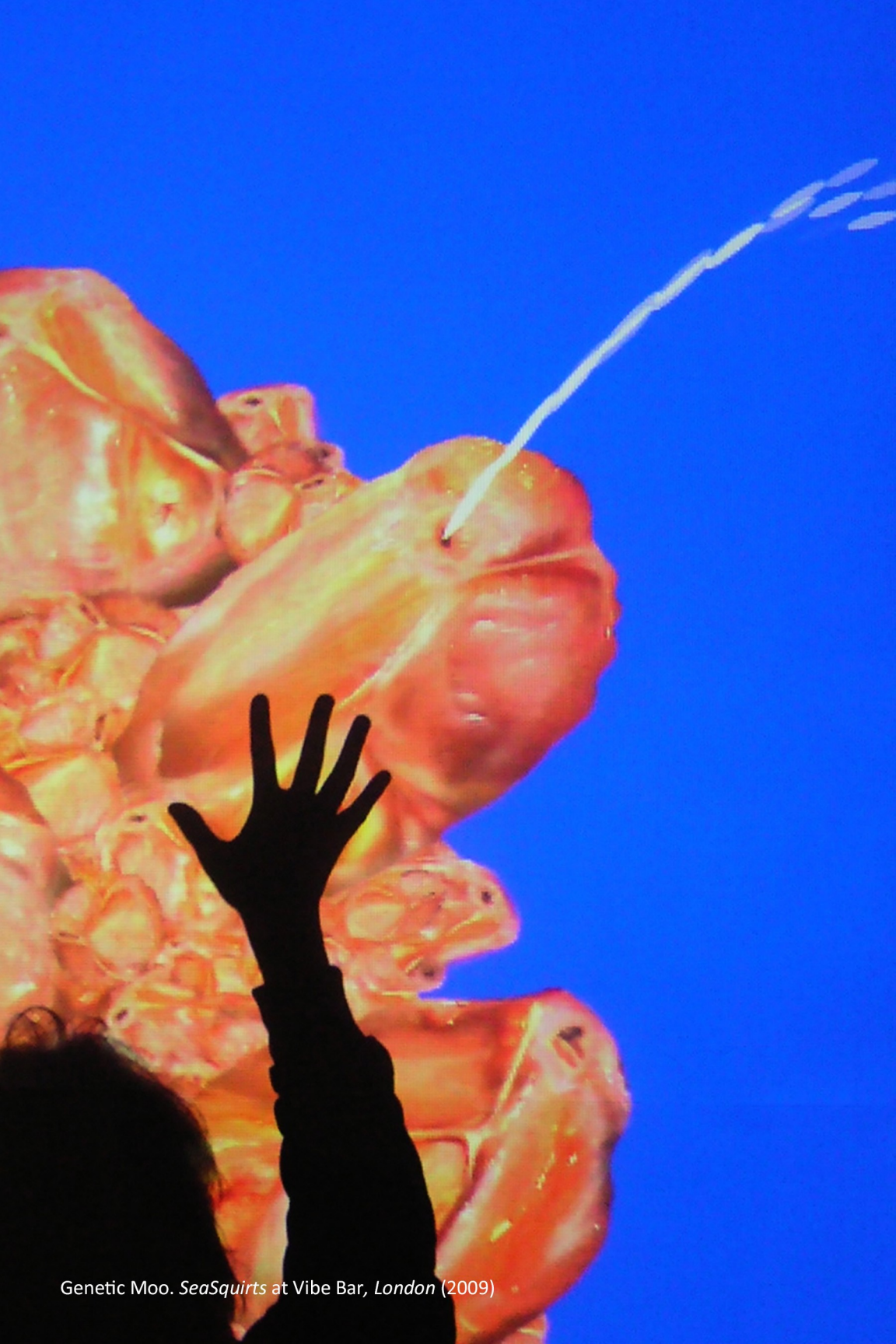
We also see interactive art as the 'best' form of computer art. We respect, but don't understand why artists would use computers to mimic things that painters or printmakers can do? To make their computer art look more artistic?! We want to use computers to do things that can only be done with computers. And interactive art is one of those things. To us the essence of computer art is interactivity. We see it as essential.

Focus

So we had all these ideas and were putting on shows with non-digital artists, even painters. We were making plenty of new pieces but we felt something was missing. Perhaps some sense of a shared mission - we needed to find our people. We attended Furtherfield shows in London, a great hub for connecting computer artists, and were impressed by how smart Ruth Catlow and Marc Garrett and their friends were. Their mantra "Do It With Others" was cool. We contributed to some more group shows and even wrote letters to other digital artists in the UK whom we admired and who were ahead of us in their practice. Often they were artists who were also academics. They wrote back with polite encouragement but revealed no secrets to making money in interactive art. Was nobody making a living in this field?

Rather than new ideas (we had too many), what we really needed was a clearer focus on what we were doing, so we could better pitch it to potential commissioners.

And to improve focus, a great idea is to do some research.



Genetic Moo. *SeaSquirts* at Vibe Bar*, London* (2009)

Sean Clark. Interacting with *The Whale* (2012)

3. I am the Researcher / Sean Clark

We've known Sean for ages; he's one of our best friends in the digital art world - we've worked together many times, shared many commissions. So we understand that he will be slightly vexed by being put into the researcher slot, because really he calls himself an independent artist, curator and researcher. But this is our book. The reason we wanted him to contribute is because he was one of the few people who put us on this track. Back when we had done some interactive pieces in group shows, we were looking around and came across *The Interact Gallery* in Leicester. This was a space run by Sean to engage the public with this newish art form. We thought we might get a show out of it, so we went up to meet him, and he did eventually offer us a show, but he also blew open our minds with his systems-thinking approach.

Exhibitions as Systems

1. Introduction

During my formal research studies at De Montfort University between 2009 and 2018, I developed a practice-based research method structured through iterative cycles of what I refer to as **Theory–Create–Exhibit–Reflect**. Over time, I came to understand this process as a spiral, in which each cycle feeds into the next, resulting in both the development of a body of digital artworks and an evolving theoretical position. While all artistic practice involves forms of research (we might refer to the process of selecting materials as "research"), I found that working with a more formalised practice-based research structure helped me to articulate my process more clearly and communicate it to others. My approach draws on the work of Linda Candy, Ernest Edmonds, and

Stephen Scrivener, whose ideas have influenced my thinking since my time at Loughborough University in the 1990s.

A key aspect of my art-making approach is the role of exhibition. I do not treat exhibitions as endpoints in a process of artistic creation, but as active environments in which my digital art systems can be encountered, tested, and understood by myself and audiences. What I may think of as a **whole** is typically composed of interacting **parts**, and those parts may themselves be **subsystems**, with each containing yet more parts. The boundaries between parts and wholes may shift during reflection, and embracing this dynamism of viewpoint, rather than seeing the world as composed of fixed, rigid hierarchies, is an important principle in my process. This approach has often led me to question where the system boundaries lie in my own artistic practice. Is my entire practice itself a single artwork, composed of multiple interacting artworks? What roles do the artist, participants, and exhibition space play within it? Does the artwork exist without participants? Where does agency sit within the work?

A key moment in the development of these ideas was the *Symbiotic* exhibition, produced in collaboration with Genetic Moo at Phoenix, Leicester, in 2012. In this exhibition, multiple digital art systems were brought together within a shared space. Three artworks by myself and three by Genetic Moo. This exhibition, hot on the heels of my previous work, *The Interact Gallery*, shifted my focus away from individual artworks towards the relationships between artworks, the audience, and the gallery environment. While I had long seen my individual artworks as systems, *Symbiotic* showed me that exhibitions could be considered as cybernetic and ecological systems in their own right, with artworks and participants functioning as parts within a larger whole.

The **Theory–Create–Exhibit–Reflect** model continues to shape my creative practice beyond my formal research studies, and I still use it to structure and reflect on my practice as it develops, helping me better understand both the art systems I create and how best to communicate the ideas that underpin them.

2. Theory–Create–Exhibit–Reflect

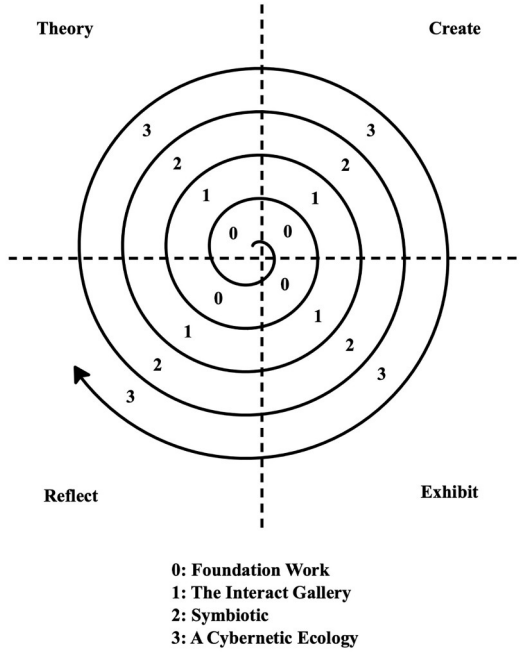


FIGURE 1: THE THEORY–CREATE–EXHIBIT–REFLECT MODEL.

Initially I presented my cycles of **Theory–Create–Exhibit–Reflect** as concentric circles. But I began to see them as forming a spiral, where each iteration builds on the last (see Figure 1). Starting with **Theory**, the research cycles (numbered from 0 to 3) go through a process of **Create** and **Exhibit** leading to **Reflect** and a repositioning of **Theory**.

2.1 Theory

The **Theory** phase establishes the conceptual grounding for that cycle of artwork creation. For me, this generally includes engagement with ideas from systems thinking, cybernetics, and digital art practice, alongside the results of my reflections on my previous cycle of work. **Theory** includes the ideas I want to explore, an indication of how I might do this, and a rough idea of what I should be looking for during the process.

2.2 Create

The **Create** phase involves developing new digital artworks, or digital art systems as I now describe them. These works are not simply illustrations of **Theory** but are operational environments in which ideas can be explored and tested. Writing code, defining rules, and constructing interactions are all part of this. The behaviour of these systems, particularly over time, becomes a key point of inquiry. As part of my research, I document my working process through blog posts, short essays and notes, photographs and videos. However, I generally try to remain focused on making during this phase, since theorising and creating simultaneously can lead to unnecessary procrastination on my part.

2.3 Exhibit

Exhibit places these systems in a public context. Exhibitions are seen as active environments where the work leaves the studio and can be encountered in real conditions. The presence of audiences, the influence of space, and the duration of the exhibition all introduce variables that affect how the art systems behave and can be understood. Documentation is important in supporting the later reflection process. Many of my most useful insights into my work have come from reviewing exhibition records.

2.4 Reflect

The **Reflect** phase involves reviewing and analysing the outcomes of the **Create** and **Exhibit** stages. Observations of system behaviour, audience interaction, and contextual factors are considered and developed into more formal insights. These reflections directly inform the next iteration of the process, shaping both the theoretical position and the direction of subsequent work.

2.5 The Spiral Structure

While each of these cycles can be identified individually, their significance lies in how they operate together over time. The process does not return to the same point with each cycle; instead, it moves forward enhancing my

understanding of my work, forming a spiral. Each iteration incorporates what has been learned previously, allowing both the work and its underlying ideas to develop in parallel.

In my formal research, this spiral was expressed through a series of research cycles, as explained in the next section.

3. Research Cycles

During my formal research at DMU, my progression can be traced through four key research cycles: starting with *Foundation Work*, followed by *The Interact Gallery*, the *Symbiotic* exhibition, and finally *A Cybernetic Ecology*. It should be noted that, while one goal of these cycles was to put me in a position to argue successfully for a PhD, my overarching aim is always to use this approach to make better artwork and to understand how systems thinking can help me do this.

3.1 Foundation Work

FIGURE 2: AUTOPOIESIS (2008)

The *Foundation Work* phase established the initial conditions for the research. During this period, I reviewed a number of my previous artworks from a systems perspective. I selected post-2006 works that I felt were important in helping me to identify the core ideas behind my practice, particularly the idea of the artwork as a system rather than a static object. The works included a piece I called *Autopoiesis* from 2008 that explicitly explored the idea of an artwork as a self-creating system. The term autopoiesis was coined by Humberto Maturana and Francisco Varela to describe the core property of living systems and is further described in their book 'The Tree of Knowledge'.

3.2 The Interact Gallery

FIGURE 3: THE INTERACT GALLERY IN LEICESTER (2011)

Having identified my initial idea, basically that digital artworks could be seen as systems, *The Interact Gallery* (2010-2012) provided the first opportunity to explore these ideas within a sustained exhibition context. Here, the work was no longer encountered in isolation, but as part of a curated environment over an extended period of time. This phase allowed me to begin thinking about how multiple interactive artworks might coexist within a shared space, and how audiences engage with them in situ. It also reinforced the importance of exhibition as an active component of my research process, rather than a final stage of presentation. Importantly, reflection on this exhibition highlighted the importance of documentation. I had interviewed quite a few participants about their experience of the exhibition, but my key insight during the reflective stage did not come from these interviews, but from re-watching an exhibition video in which I could see two of my artworks interacting with each other, without a participant present.

3.3 *Symbiotic*

FIGURE 4: SYMBIOTIC AT PHOENIX, LEICESTER (2012)

The *Symbiotic* exhibition, developed in collaboration with Genetic Moo in 2012 and shown at Phoenix, Leicester, marked a significant shift in my thinking. I now wanted to explore how it might be possible to bring a collection of digital artworks together in a shared environment with the intention of encouraging them to interact with each other, not just their human visitors. This led me to focus more directly on the relationships among artworks, audiences, and space. Three interactive artworks by myself, *The Whale, Red Spinner* and *Blue Spinner*, were installed that responded to colour and movement and three from Genetic Moo, *Cockatoo Squid, It's Alive! Ants* and *Starfish*. I experienced and then analysed this exhibition extensively, mapping the ways in which the artworks interacted with each other, both with and without participants in the gallery.

3.4 A Cybernetic Ecology

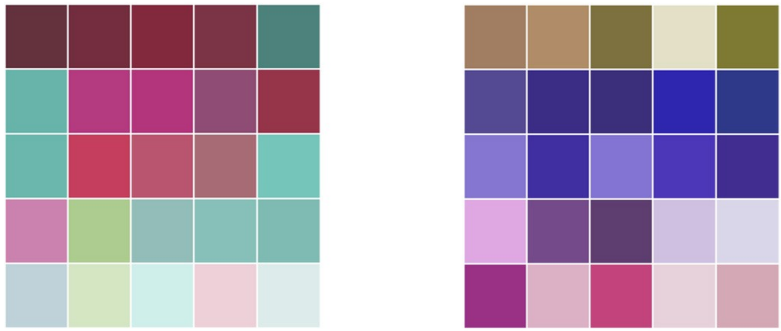


FIGURE 5: SYSTEM ONE, REPRESENTATIVE OF MY NEW VISUAL STYLE (2016)

My final phase of work within this research was titled *A Cybernetic Ecology*. It built on the developments of *Symbiotic*, extending the idea of interconnected systems into a more explicit conceptual framework. It also saw a significant change in the style of my artwork. I moved away from the video loops and feedback I had typically used before and adopted a more precise, "minimalist" style in which it was possible to see the interaction between the artworks through the exchange and sorting of colours Here, the focus had fully shifted to understanding the exhibition as a complex, dynamic environment in which multiple art systems (25 in total) operate simultaneously and influence one another. This phase of work consolidated my move towards thinking about exhibitions as cybernetic and ecological systems, bringing together the insights developed across earlier cycles and setting a new foundation for my artwork that continues to this day.

4. The Legacy of *Symbiotic*

Symbiotic represented an important step in both Genetic Moo's and my own artistic development. For Genetic Moo, it helped to establish an approach that would later underpin their highly successful *Microworld* project. For me, it provided a context in which I could identify a new direction in my own practice, shifting my focus from individual artworks towards the relationships

between computer artworks, audiences, and environments that could be seen in *A Cybernetic Ecology* and my more recent works such as *Computational Constructs* (2026).

5. Conclusion

The **Theory–Create–Exhibit–Reflect** model has provided a way of understanding digital art as a system of processes rather than a collection of objects. This perspective highlights the importance of relationships, behaviour and time in shaping how artworks are experienced. It also suggests that exhibition-making can be approached as a form of system design, where curatorial decisions establish the conditions for interaction and emergence. Ultimately, this approach offers a new way of thinking about digital art and exhibition practice.

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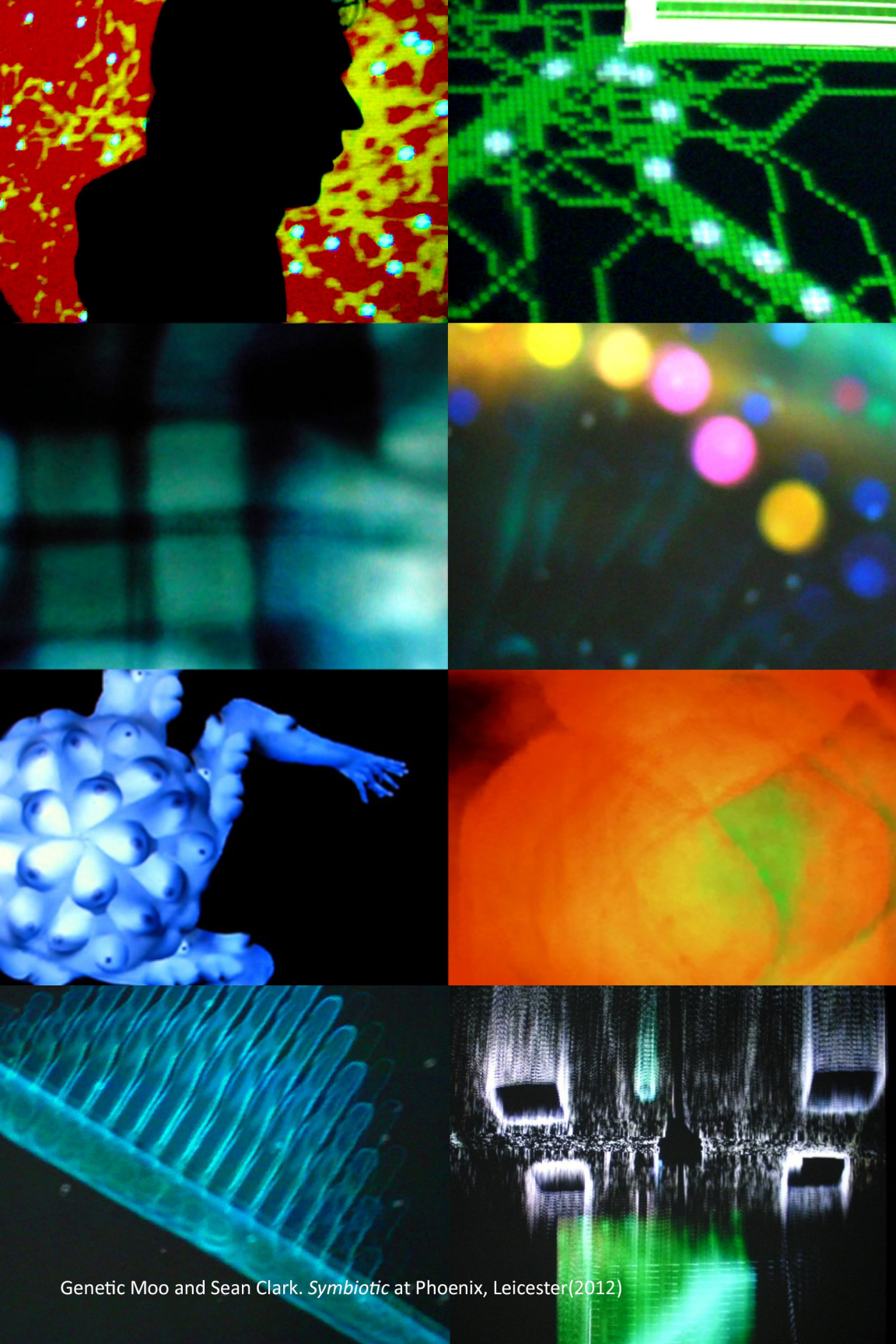


Genetic Moo and Sean Clark. *Symbiotic* at Phoenix, Leicester(2012)

What does an interactive art work do when there is nobody in the space?

The pieces sit in an empty gallery looking out into the space. They can see each other, but there is no human to interact with, instead we design the pieces to interact with each other. This was an idea we developed with Sean Clark in our *Symbiotic* exhibition at the Phoenix in 2012. We each made several pieces which responded to the visuals and the sounds in the space. It was great to sit in a corner, out of view of the webcams, and watch the exhibition ticking over, never exactly repeating itself and occasionally going into swooping call and response sections. The space had its own moods and rhythms - it felt alive.

Systems

By applying systems thinking to our practice, we could see a fruitful path forward. If you focus on how pieces affect each other you will find a web of activity. In nature you might call this a food web. In our case pixels, data and sound samples are being passed around. By adding new pieces into a space the web increases in complexity as more links become possible. If you do this right then at some point the system becomes more than the sum of its parts. The system becomes its own thing and a sense of place emerges. And this place is where you take your audience.

Emergence?

Incidentally, during this show we had an exciting experience. One piece consisted of two virtual ants nests on the walls with ants scurrying back and forth across the space in and out of the nests following pheromone trails which they built as they went. After the install we went away and then came back after several weeks to be confronted by an extraordinary sight. The ants had managed to build flickering pixels across the walls. This was something that we had never seen before in the program. We were so excited. One of the computer artist's dreams is to create a computer program which does something that surprises the artist. Even with millions of pixels moving around with millions of random numbers, this is much harder than it seems. So we were thrilled. Something new had emerged from the complex interactions. That is until we started to think it through more carefully. Some

of the new pixels on the walls were flicking between black and white. There was no way this could happen in the code. Then it dawned on us - these were the dreaded dead pixels. We'd witnessed one or two before, but not hundreds. It turned out that the projectors had been left running 24/7. Back then, projectors weren't as economic as they are now and dead pixels were an issue. So, a parochial explanation, but it goes to highlight an important point about interactive art and art in general: the artist is happy if something unexpected happens.

To take this further, using computers is a great way to get away from your own artistic 'signature' which can sometimes be restricting - you just get sick of your own style. Moving into pixel land forces you to rethink the way your art is put together. And combining this with random decision making takes you into completely unchartered territory - which is liberating.

Microworld

So after working collaboratively and discussing systems art with Sean we started to see a way to conceptually link together a lot of what we had already been doing. To reframe a collection of individual pieces into a living digital ecosystem. We'd install several interactive artificial creatures next to each other so they could interact across the space and then invite the audience into the middle. This show idea became *Microworld* which you will hear mentioned a lot in the following chapters. We will explain *Microworld* in more detail later, but for now it is sufficient to see that it was a way for us to create bigger shows and to help curators get a handle on what we were doing, and hopefully commission us to do it some more.

We even won a prize.

Genetic Moo. *Microworld Cardiff 2* at ArcadeCardiff (2014)

Genetic Moo. *Mother*. Awarded the Lumen Prize Founders Award (2013)

4. I am the Prize-Giver / Carla Rapoport

We first met Carla Rapoport in Cardiff at the second annual Lumen Prize when she awarded us her Founders Award. We weren't sure what to make of Lumen to begin with. There were a series of cash prizes in different categories, for digital and technological art. It provided a UK alternative to the corporate and remote international digital art prizes. There were some fantastic early prize winners, though some of the art looked weirdly old fashioned and the gallery rendering was a bit basic, with pieces stuck to the wall with blue-tack. But we sensed they were going somewhere, and over the years they gained in skill and confidence. As a growing organisation, we were a good match. We started working with them on more and more projects, including some where we all got paid! After several years of projects we decided to take our collaboration to the next level and work together with Lumen as our official producers.

Here we ask Carla a series of questions:

- What was your motivation for setting up the Lumen Prize—what was out there that needed improving?

After a career in financial journalism I wanted to dive into something new, something I could do from rural Wales but also something that made a difference. I've always loved art and wrote extensively about technology in my career, but never thought there might be a link between the two. Then, In 2012 I visited the David Hockney retrospective at the Royal Academy. I went back multiple times and found myself explaining the work mounted in the iPad room to the people around me. I was dazzled by the depth of colour in the screen-based work and the fluidity of Hockney's projected videos. It occurred to me that he couldn't be the only artist working with technology—this sent

me down a rabbit hole and resulted in the Lumen Prize. It seemed to me that digital art was being neglected by the contemporary art world and there's nothing I like better than a vacuum!

- An important feature of the Prize was the international touring program. Tell us about how you were able to organise this and its value to Lumen and the participating artists.

My career had taken me around the world and I used my contacts to find galleries that would be willing to show Lumen Prize work. As the early winners were primarily emerging artists, they were thrilled to have the opportunity to exhibit. This raised interest in the prize among artists and it brought global attention to the Prize—a win-win.

- How did Lumen expand? (new staff, new venues, new contacts) We'd be interested to hear how Lumen and its reputation grew so quickly?

The short answer is: Right idea at the right time. Art colleges were busy responding to their students' interest in digital and all things tech while museums were playing catch up too, so we found ourselves in demand. And those global tours put us on the map both at home and abroad. Having a Facebook community was more of a thing in those days and that really helped too.

- In 2014, Genetic Moo accompanied Lumen to Hong Kong (our first international show). How did this show at The Space come about?

I had lived and worked in Hong Kong for eight years and had many friends still living there. One of those friends was Serena Wallace Turner, a passionate supporter of the prize. Serena had a friend with a consignment gallery which was between shows for a few weeks that spring and we were in business!

- *Microworld Brecon* was an important early project for us and Lumen, involving your home community.

Microworld Brecon appealed to all ages because you could step straight into it —you didn't have to learn anything or behave in a certain way to enjoy the experience. The technology went on in the background. Also, this *Microworld* included a live video which 'ate' a projection of the canal outside the venue. Visitors loved the interaction with their town.

- At Brecon we discussed both our futures and the idea of a sister Lumen production company came up. Can you tell us more about the thinking here?

We were always looking for new sources of income. Also "Lumen in a Box" which we could market internationally had long been a dream.

- How did you secure bigger shows? Such as Eureka! and Ithra?

The curator for Eureka heard me give a talk at a Lumen exhibition in Leeds and got in touch. Again, travel—getting out of London for example—was key to our early success. Ithra was a contact of Eureka's and they introduced us.

- Now the Lumen Prize has a new home in the USA. What do you see as its future?

It's exciting to see Lumen evolving in a new way. It is now exclusively a prize, there is no exhibition programme as such. It's also a registered US charity so can accept sponsorship from individuals and corporations which is great. I remain on the board and am excited to see where the Prize goes next.

Carla adds an extra question:

- What was different about Tim and Nicola?

From the first time I met them at ArcadeCardiff in 2013, I knew I was meeting two very special artists. Unlike many of the other winners, they were generous with their time and if they were a bit skeptical of the early Lumen, they didn't show it. They radiated enthusiasm for the idea of Lumen and reinforced my belief that there was an audience out there for this kind of work. Also unlike other artists, they answered their emails and were clear communicators. This may sound minor to those in other professions but in the arts, it's mega. It meant we could count on them to come through, work to deadlines and troubleshoot problems when they cropped up.

I've felt they supported Lumen all these years and am honoured to learn that they credit Lumen for some of their success. It was my colleague Jack Addis who handled most of the Lumen-Genetic Moo interaction but I'm pleased it was my first Founder's Award that brought us together.

Award Winning

When you are starting out as an artist it is difficult to get curators to consider your art for their next project. There are so many artists and not enough time to see them all. One way to stand out a bit is to upgrade the prefix you use before your title. So, and these are roughly in order of merit as we see it, you can be an 'emerging' artist, a 'mid-career' artist (boring), an 'established' artist (yawn), an 'award winning' artist (getting better), an 'international' artist (good). We have been all of these and are currently an 'acclaimed' artist duo. There's a kind of hidden rule: you are not allowed to just appoint these words yourself, someone else needs to describe you in that way. But who's to tell? One thing we are not is 'cutting-edge' artists. We use everyday, readily available and, in some cases, old fashioned technology.

Genetic Moo. *Microworld Brecon* at Theatr Brycheiniog, Brecon (2018)

Genetic Moo. 360 view of *Microworld Amelia* at The Amelia, Tunbridge Wells (2023)

5. I am the Curator / Edward Liddle

We showed *Microworld* at The Amelia in the summer of 2023. Our 17th *Microworld*. We met Edward, the Curator, and immediately got on with his calm and collected manner, and expert knowledge and ideas. Not only does Edward run all the exhibitions in the temporary exhibition space at The Amelia, he is also the chief technician. He did all the construction: building plinths, seating, stands and so on; painting the walls; and designing and installing the interpretation. Truly a master of his domain.

What makes a good exhibition? How are exhibitions chosen and why do some exhibitions resonate whilst others don't seem to connect with audiences?

As curator for The Amelia, a smallish-sized arts and cultural centre in Tunbridge Wells, I am required to turn my hand to most things, from project managing to painting walls. My main responsibility, however, is the curation of three temporary exhibitions per year, and I have an interesting brief to fulfil.

First and foremost, The Amelia is managed by the local council. Following a £25 million refurbishment project in 2022, which brought together multiple services in one combined building, The Amelia now comprises a public library, permanent museum displays, an adult education facility, front line council services and the Temporary Exhibition Space.

The audience passing through the doors of The Amelia is incredibly varied. Some visitors come to experience the museum displays, or to borrow a book whilst others visit to pay their council tax or to seek support from the wider council team.

In order to reflect the audiences coming to The Amelia, and to try to appeal to the largest cross-section of these visitors, the temporary exhibition programme varies throughout the year.

When programming the exhibitions, I try to keep in mind several factors. Firstly, relevance, why this exhibition? What is it about the themes present in the exhibition that have some relevance for our audiences or for the place we are located in? The objects in our collection help steer this a little, with The Amelia holding a collection that touches on photography, the natural world, fashion and textiles as well as royal connections. We have also established a reputation for working with artists on new collaborations.

Choosing exhibitions that align with our collection and which also build on our past experience ensures that we are able to deliver relevant high quality experiences for our audiences, whilst also developing their interest in themes that are historically linked to the place. However, we must also work to ensure that the desires and appetites of our audiences are met.

No one audience is the same, and it would be reductive to place labels on those that walk through our doors each day. Instead we try to strike a balance. The sweet spot lies between responding directly to visitor feedback, which is captured through surveying and to introduce new things to our audiences.

Tunbridge Wells is home to many families and this audience is directly referenced in the way The Amelia functions, with welcoming family friendly spaces embedded throughout the building and wider programming that seeks to engage families and young people. Of our three exhibitions per year, none represents this need to fulfil a brief and meet our audience's desires more than our annual summer programme.

Primarily, our summer programming must appeal to family audiences; parents with children as well as child minders and grandparents whose summers are filled looking for things to do locally.

However, The Amelia doesn't only welcome family audiences every summer. Our ambition, therefore, is to reflect on how our summer exhibitions can bring out the child in all of our visitors, inspiring them to play, imagine and dream.

It was with these requirements for the exhibition programme at The Amelia in mind, that I first encountered the work of artist duo Nicola Schauerman and Tim Pickup; AKA Genetic Moo. Their exhibition *Microworld* was included on The Exhibitions Group website, a place where touring exhibitions are listed for curators and producers to browse.

Before working with them, I had no experience of working on interactive digital projects and so was unsure whether *Microworld* would be a good fit for The Amelia. I anticipated that such an exhibition would be too expensive, too complicated and unmanageable for my time and budget constraints. I had no experience of setting up and installing such an exhibition, and felt that it may be out of our reach.

I was also sceptical of exhibitions that claimed to be interactive or immersive. Experiential exhibitions, particularly those featuring floor to ceiling projections, have been growing in number and popularity. Such exhibitions are advertised as being interactive, whereas in reality, licensing the work of long dead artists, they use projections and animations to guide visitors through an 'immersive experience'. The resulting exhibitions become repetitive, passive experiences for audiences and do not encourage meaningful engagement.

Speaking with Nicola and Tim during our initial conversations I was convinced that *Microworld* was not like these other exhibitions. First and foremost, being artists, I felt excited to work with them and importantly, they were engaging, positive and highly experienced.

Nicola and Tim understood where I, as a curator, and The Amelia, as an organisation, were coming from. They were ready to meet some of the challenges that we are required to consider when working on the exhibition programme and had lots of ideas. Not only would the exhibition constantly change and develop during its time on display at The Amelia, which would encourage repeat visits, but they were also excited to use objects from our collection to create digital replicas and insert these elements into existing artworks.

What followed was a fruitful collaboration between Genetic Moo, their production team and staff at The Amelia. The exhibition received record numbers of visitors and glowing positive feedback.

With many visitors returning several times throughout the summer the exhibition, which was free to enter, also represented extremely good value for money. The exhibition exceeded the target ratio of 'total spend to visitor numbers', something that is always assessed and which is vital that the exhibitions at The Amelia meet, due to all money being spent deriving from taxpayers' money.

So why was *Microworld* such a success? Like all good art, it has a distinctive point of view and offered multiple entry points for audiences. Some came to experience the bright lights, and strange noises that were produced when they interacted with the artwork. Others came to understand more about the coding which formed the mechanics of how the artworks were created and functioned. Equally important, the exhibition was a fun, welcoming place for discovery. Whether paintings on a wall, or large digital interactives, this for me marks the true success of an exhibition. Are audiences encouraged to learn something new, to see again the things they thought they knew? For *Microworld: Amelia*, the answer was a resounding… *yes!*

Genetic Moo. *Chicken Monster* at The Amelia, Tunbridge Wells (2023)

All shapes and sizes

We have worked with many curators over the last 10 years, and there are many different approaches. Hands on, hands off, traditional, experimental etc. Our project is multi-faceted and adaptable. It can be displayed in different ways: on a tablet or scaled up to fill a warehouse. So there is plenty of curation to be done. Every venue is a different shape and size and so too are the audiences and what the venues hope to offer them. Luckily we enjoy adapting our art and this pushes the project forward and keeps things fresh.

Every show is different. We love to try out new combinations and ways of showing the works. Some venues have quiet rooms which might suit a film or a generative (non-interactive) piece like Mother. Some venues have invigilators which means we can use torches or tablets or other physical objects which need looking after. Interactives can be shown on walls, ceilings or floors.

These possibilities are discussed with the curators and technicians beforehand and we know the museums appreciate the fact that they are getting a unique show. Sometimes through conversations or visits we come across a local object or story that can be turned into a new piece (or a variation of an old piece). Our *Dudley Bug* interactive is a great example of this. We created a new digital species of metallic trilobite, referencing both Dudley's beloved fossil and Wolverhampton's steel jewellery industry. You never know what you'll find.

De-sexing

In the early days, there was a stronger sexual component to our creatures, which were collaged from our own organs, sexual and otherwise. Our Animacules piece is now just made of fingers and thumbs. Year by year, sometimes on the request of our curators, limbs have been removed or flattened so that the Starfish, which used to have numerous breasts and bottoms, is now a black silhouette. This reminded us of the Peppered moth in nature which evolved into a black form so it would be better camouflaged during the Industrial Revolution. It adapted. We have been OK about neutering these pieces. When the time is right we will triumphantly bring back the originals in what we guess will be an adult version of our shows.

Genetic Moo. *Becoming Starfish* at *Electric Blue*, The Bargehouse, London (2008)

Installing *Microworld Ithra* at The King Abdulaziz Center for World Culture, Dhahran (2020)

6. I am the Producer / Jack Addis

We have been working with Jack for over a decade. We definitely could not have got where we are today without him. So thanks Jack.

We started out by asking him how he manages all his roles: producer, networker, negotiator, show designer, equipment purchaser, technician, troubleshooter and promoter.

How I juggle all of that is hard to explain because I never really sat down and decided to do all of it; I just got on with what the work needed and built up the skills as I went. My background is as an artist, and I started working with digital technology around 2010, moving into gallery work as a technician when it became clear the infrastructure for a career as a digital artist was not really there yet, and from there into a Masters in Digital Art. In 2016, while I was installing a student exhibition, I met Carla Rapoport, founder of the Lumen Prize, and that led to ten years of work: curating and producing around seventy exhibitions and events focused on supporting artists working with digital technology.

I first started working with Genetic Moo in 2016, they were part of an exhibition I was curating and producing at Leeds Dock. *Microworld* is an interactive art project that deals with ideas around ecosystems and life cycles, made up of many creatures that visitors can interact with through movement, sound and play, and it was one of the earliest shows I worked on with Lumen. Over the following years we kept working together, and that relationship is still going now, which I think says something about how the work has developed and the trust that has built up between us over time.

Producing digital artists

I work with a number of digital artists and most of them are interactive artists, which comes with its own set of demands that a lot of venues and producers have not had to deal with before. That side of the work grew organically out of the Lumen network rather than being something I planned from the start. Artists came to me through connections that had built up over years of being embedded in that world and understanding what they needed. Whether a project gets produced depends a lot on the budget and the venue and the technical complexity. Some of the most technically demanding work I have been involved in has also been the most rewarding, but if the budget is not there to support it properly or the venue does not have the infrastructure or staff capacity to host it well, then it does not serve the artist or the audience to push ahead regardless.

Finding TEG

For a while I was finding my way through the museum sector without much of a framework for how it all worked. Museums were finding us online, and conversations were starting but I did not have a clear picture of the touring exhibitions world or who the key people in it were. Finding TEG (the Touring Exhibitions Group) now called The Exhibitions Group, changed that. It is the national membership network for people working in touring exhibitions across the UK, bringing together museums, galleries and venues, and I started attending their events and meeting curators and exhibition organisers from across the country. At the first event I went to, we showed some interactive work by Genetic Moo on a screen. This allowed delegates to interact with it and get a sense of what it was. I also did a presentation about *Microworld*, making sure to get across the information that would matter to museums—facts and figures about costs, visitor numbers, and quotes from visitors. That's the language venues need to hear when you're asking them to take a risk on something unfamiliar.

What was striking was that we were almost the only people in those rooms with a digital exhibition. The touring world at that point was overwhelmingly physical, objects in cases and prints on walls, and interactive digital work was something most of those venues had not really had to think about before. That

made the conversations interesting but it also meant much explaining about what the work was and what it needed. TEG gave us a way into relationships we would not have found otherwise, with people who already understood how touring worked and who were curious about what we were bringing into that world.

Venue relationships

One part of my job that I enjoy a lot is the long-term relationship building with the people at museums and cultural institutions. A venue that has had a good experience with you is a venue that will come back, and mostly that happens naturally through doing good work and making the process as straightforward as possible for the staff on the ground, rather than through any formal relationship management. Whether that leads to another show depends heavily on their programme and budget cycle. Venues are typically planning twelve to eighteen months ahead and their budgets are set through local authority or funding body processes, so even a genuinely successful show has to compete with everything else they want to do in a given year. Once a venue has had an interactive show and seen how audiences respond to it there is definitely more appetite for doing it again. But patience is part of the job and the relationship matters more than trying to push for a quick follow-up.

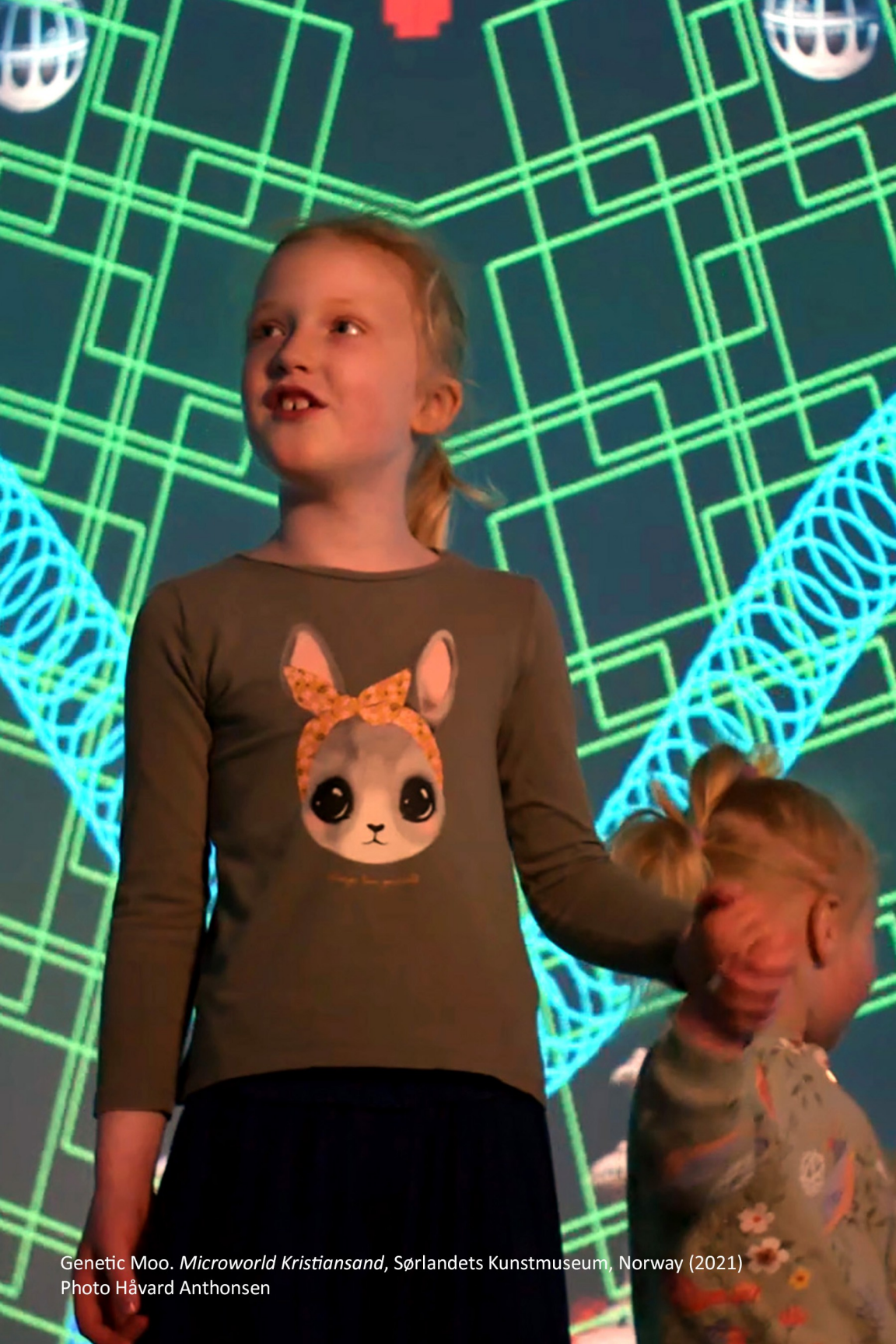
Moving to KitMapper

Moving from Lumen to KitMapper has meant learning to let go of some of what I used to carry on my own. When you are a one-person operation you are across every detail because you have to be, and working with a bigger team means trusting other people with parts of the work that you used to own entirely, which is an adjustment. The core challenges are the same: getting artists paid fairly, getting work seen by people who would not otherwise encounter it, and navigating the gap between what artists need and what institutions can offer. But having a team around you changes what is possible and also what is expected of you. You're not just delivering work any more, you're helping build the structures that let other people deliver work well too.

Art or entertainment

The question of permanent interactive spaces, along the lines of the TeamLab model, comes up more and more. My honest view is that some of those endeavours stray into art as entertainment and, if an artist is happy to show their work in that format, then that is a completely valid choice. But it is not right for every artist or every practice. The work I care about tends to be more specific than that. It has something to say and it needs the right context to say it. That's why getting it into the right venues, in front of the right audiences, in places where people actually live rather than places they travel to specifically for an experience, still feels like the more interesting and more important thing to be doing.

I still think about the idea that somewhere a child who stood in front of one of these exhibitions might one day make work that does the same thing for someone else - and that is still what I am trying to make possible



Genetic Moo. *Microworld Kristiansand*, Sørlandets Kunstmuseum, Norway (2021)
Photo Håvard Anthonsen

Genetic Moo. *Microworld Amelia* (2023)

7. I provide the tech / Ryszard Lewandowski

KitMapper is one of the UK's most trusted technical producers for artists, galleries and cultural institutions. Founded in London in 2012, it began as a small, community-driven, equipment-sharing network and has since evolved into a professional service company handling production, installation, design and fabrication. KitMapper's ethos is built around access: making high-quality audiovisual and interactive technology available to artists who might not have the resources to own or store it, while ensuring installations run safely, smoothly, and on schedule. They bridge the gap between a creative vision and its technical execution and they do so seamlessly, often invisibly.

In this chapter, KitMapper's Deputy Director, Ryszard Lewandowski, offers a grounded view of this 'invisible' layer.

Interactive art has a funny way of looking effortless when it's working right. You walk into a room, you do something, and the art does something back. It feels like a simple loop: curiosity leads to action, action triggers a response, and that response lands as delight, surprise, or recognition. That's the visible magic.

The hidden side is a bit less poetic. Those loops feel effortless because someone has obsessed over the boring stuff: where the power comes from, what happens when the Wi-Fi drops out, how you stop a computer installing updates mid-show, what you do when a small child drop-kicks a sensor, or a well-meaning staff member switches the wrong thing off when closing up for the night.

My team's job is to make that boring stuff behave. We help the artwork do its thing safely and reliably, over and over again, for the full run. We often take a

studio prototype, where everything is controlled and the artist is nearby, and translate it into something that can survive the real world: galleries, museums, foyers, festivals, shopping centres, schools. We supply equipment, integrate it, install it, test it, document it, support it, and eventually de-install it. It isn't glamorous, but it's a huge part of the artwork's life.

Interactive work can look simple on the surface, but the systems behind it can be complex: sensors, screens, speakers, microcontrollers, playback computers, networks, mounts, and power distribution. Then there's the environment: opening hours, cleaning routines, other events, the lighting focus happening while you're calibrating a camera. If a venue is going to host ambitious interactive work, they need confidence: it won't break constantly, it won't endanger visitors, and it won't require the artist to be on permanent standby. Ideally, the first visitor and the ten-thousandth visitor get the same quality of experience. Crucially, you need a plan for when things go wrong.

The real world is a tough place

In a studio, you control almost everything. In a public space, you control almost nothing. It's kind of hostile out there, nobody is actively trying to destroy the work, but public life is hard on technology.

People press, pull, lean, tap, and repeat actions to see what happens. Sound is unpredictable: a quiet weekday test is nothing like a busy opening night or a school visit. Light shifts through the day and can change how sensors behave. Power is rarely where you want it, sometimes limited or switched. Networks are a headache: guest Wi-Fi, blocked ports, password changes, firewalls. And time is always tight: install windows shrink, deliveries run late, spaces aren't ready.

In a sense, we act as translators. We take the artist's intent and build a technical system that can stand up to those conditions, without feeling over-built. The best technical solutions are often the ones you don't notice.

Working with groups like Genetic Moo, the technical side becomes part of the creative process. A small change in placement, sensitivity, volume, or timing can change how an interaction feels. Over time, venues, artists, and technicians

build shared knowledge: what lasts, what fails, what visitors actually do. That practical learning is a quiet R&D engine for the wider cultural ecosystem.

Reliability is a process, not a promise

A good interactive setup isn't one that never fails. It's one that fails gracefully, recovers quickly, and doesn't ruin the audience experience when a small thing goes wrong.

We think in layers:

Design for repetition. Choose components rated for heavy use, mount sensors so they don't drift, strain-relieve cables so they don't wiggle loose.

Remove weak links. If something doesn't need the internet, it shouldn't use the internet. Lock down computers, disable pop-ups and auto-updates, remove anything that can interrupt playback.

Make it serviceable. Label cables and spares, leave slack, and avoid designs that require dismantling everything to reach one power supply.

Document and test. Create simple diagrams and checklists (connections, restart steps, escalation points), then test in real conditions; lights on/off, noisy/quiet, with real humans.

So… what does it cost?

Every job is different, and the numbers are always part of a negotiation. But it helps to understand where budgets actually go. People often assume the cost is "the kit", when the kit is only one slice. The majority is often time, planning, and care.

Here are UK-style ballparks for small-to-mid scale exhibitions (not fixed rates - just a guide):

People (often the biggest part). Interactive installs typically need technicians in pairs for safety and speed. A common on-site technician day rate is £250-

£450 per person, depending on skills and responsibility. Planning and prep can take 2-10 days before anyone arrives on site: site calls, drawings, risk assessments, equipment lists, workshop prep, and testing.

Equipment. We buy equipment and hire it out. A small mini PC might be £150-£500. Discreet installation speakers might be around £250 each, with amplifiers often £600-£1,000 depending on channel count and power. Screens and projectors vary widely, especially when they must run reliably for longer hours than would normally be required in a home!

The small stuff. Cables, brackets, fixings, adapters, tape, labels, trunking. Always leave budget for the last 10% of bits and bobs. It's often what makes the difference between "it works" and "it works every day".

Transport and maintenance. Vans, fuel, parking, loading time, awkward access: even local jobs can be £200-£600. For longer runs, plan for opening-day support and a maintenance approach (remote support, staff training, local call-outs, or scheduled visits).

The real goal is confidence

When we do our job well, we give artists and venues something valuable: confidence. The artist can trust the work will behave as intended. The venue can trust it won't become a daily headache. And the audience can relax into the interaction instead of worrying they're about to break something.

That's why I'm proud to "provide the tech". The tech isn't separate from the art. It's the quiet scaffolding that lets the artwork meet people again and again, without falling over. It makes the magic repeatable, which I think is a kind of magic of its own.

Genetic Moo. *It's Alive! Maggots* at Fire Eye Land (2021)
Photo Tom Shrapnel

Genetic Moo. *Nautilus* at *Papay Gyro Nights,* Orkney (2012)

Keep it simple stupid

We work with Technology. Technology breaks down. Components break. Computers have bad days. There is nothing you can do about it. You need to be able to respond quickly and fix or replace them. We have simplified and simplified our practice so that it is as automatic as possible. The shows run themselves.

Occasionally we will need to reset things. RemotePC, and there are lots of alternatives, was a game changer for us. If we need to reset computers we can do this remotely without bothering the local techies (or more likely the staff member who has some knowledge of computers and knows where the ladder is). We got into RemotePC during the Pandemic, when lots of people were experimenting with working from home. What it has meant is that we can provide venues with further assurance that our project will not break down - or, if it does, we can fix it smoothly with little fuss. Often in 10 minutes or less.

For a while we even used RemotePC to turn computers on and off. It saved the staff from doing it. On most days this would take about 3 minutes in the morning, and we considered it was a good thing to see the pieces were working OK. It gave us confidence, but after doing a year long show we decided this was a step too far and we generally use automatic turn on/off routines with RemotePC as a backup.

RemotePC is the first port of call for troubleshooting. We can quickly diagnose if a cable or webcam has come loose and instruct the local team what to do, in a cool and calm manner. There are lots of things that can go wrong in a tech show. You have to learn how to clearly communicate what is needed and what is and isn't working, and be patient. There is always a tech solution to any tech problem.

Genetic Moo. *Microworld* at Ferens Art Gallery, Hull (2025)
Photo Ferens Art Gallery, Hull Museums

8. We are the Events Team / Ferens Art Gallery

Genetic Moo in email conversation with Claire Longrigg

In 2025, we brought our *Microworld* exhibition to the Ferens Art Gallery in Hull, East Yorkshire. The gallery has hosted a number of mass-appeal exhibitions, including the Turner Prize in 2017, and aims to programme big family-friendly exhibitions during the summer period. The Hull Museums team has been successful in programming a number of these over the years, and they were keen to programme something a bit different at Ferens for 2025. *Microworld*, an immersive and interactive digital exhibition, seemed like a good opportunity for the team to explore. Due to circumstances outside anyone's control, our producer had to drop out at the last minute, so we had to work closely with Claire Longrigg (Exhibitions and Events Officer) at the gallery to plan the installation. Not having a producer did free up some budget and Claire, Sally Toon (Family Learning Officer) and Esther Hallberg (Access and Inclusion Manager) were able to put together an ambitious programme of activities linked to the exhibition. They also commissioned a Sensory Space called the *Microlab* designed by artist and family-engagement specialist Sarah Taylor. The exhibition achieved a huge summer audience, and surpassed the Feren's visitor target of 55,000, attracting over 60,000 visitors.

> "We programmed a broad range of events for different age groups inspired by *Microworld*. We are a small team, so it was a challenge managing lots of events alongside the exhibition, which was exceptionally busy during school holidays!" Claire Longrigg

We want *Microworld* to engage people in as many ways as possible and to do that, we need to help people feel comfortable and able to take their time with the work. Hull Museums' proposal to include a sensory space to complement the virtual interactives turned out to be a great idea. We discovered that filling

the room with physical activity toys themed around science and nature and including chill zones made a huge difference to how people used the space. It was not your typical gallery experience. At college, Nicola was told that if people spent more than 45 seconds in front of your artwork, you should consider yourself lucky. By developing the play, exploration and discovery aspects in our work, we've encouraged visitors to spend closer to 45 minutes in our exhibitions. At Ferens, families could explore the exhibition, participate in a workshop or play in the *Microlab*, and then get lunch in the café. Then they could come back and explore some more. As admission to the exhibition was free, it meant that families could come back again and again, which they did throughout the summer.

The *Microlab* sensory space filled one half of the gallery, opposite our immersive aquarium-like interactives. Sarah Taylor explains that she designed it to "complement the screen-based virtual interaction with a range of physical activities where kids could play at being scientists". There were lab coats and astronaut suits, plastic microscopes and science kits. These 'props' also allowed parents to take some fun photos for social media, sharing their experience and encouraging other families to visit. There were quiet pods and zones, coloured lighting areas and comfortable seating and beanbags scattered around, these offered great viewpoints to see the exhibition change over time. Parents and grandparents could rest and watch their kids play.

We've learnt that not everyone wants to interact, so it is important that there is always something interesting to watch. Explorer backpacks were available, containing ear-defenders and torches to control light and sound, sea creature soft toys and fidget toys—giving visitors, including children and neurodivergent individuals, the tools they need to feel empowered and confident. *Microlab* was a brilliant addition.

The huge range of special activities the Hull Museums team programmed alongside the *Microworld* exhibition went from drawing and making sessions with traditional craft materials, inspired by insects, sea creatures and mini-monsters, to more technical workshops including kaleidoscopes, paper lanterns, shadow play and stop-frame animation. These events brought out the 'science and nature' aspect of our work. There were also robot and microscope sessions. Makerspace Hull delivered digital workshops introducing beginner

Processing coding skills—the same language used to create *Microworld*. All workshops were run by local artists and practitioners.

There were storytelling, music and dance sessions, including pop-up performances in the exhibition space by dancers Tamar and Jo. The Humber Drum Circles invited people to join "an experimental musical experience for all ages and abilities". Other sessions focused on creating magical nature soundscapes filled with frogs, birds and the sounds of the forest. There were also sensory parachute games for toddlers and breakdancing for kids.

This dance workshop description gives you a flavour of the activities on offer:

Make it, move it, shake it – Microworld dance party
Are you a budding artist? Do you love to dance? Do you want to explore more creative arts activities? Are you looking to build confidence, meet new people and have lots of fun? Impact Theatre brings you an inclusive, multi-sensory art and dance workshop led by artist and creative education specialist Chris Holmes. This exciting project is open to all young people regardless of ability. In the workshop you will create your own piece of artwork and explore movement and dance in a professional creative space. Let's make and create together and 'dance like no one is watching'.

Some visitors prefer things a little less frenetic, so there were special quiet days. With digital art it is easy to alter the volume and light levels to suit different audiences. There were also Relaxed (SEND) workshops, including ones for disabled and neurodivergent adults and families with an interest in getting creative. Over the years, we have noticed that neurodivergent children can really tune into *Microworld* in ways that surprise their parents.

The gallery arranged a press call with some local school children who got to test out the exhibition, and the Hull Museums Access Panel also explored *Microworld* before we opened it to the public. There was a successful launch event on the opening Saturday, where visitors could take part in crafts, create their own *Microworld* screen print, as well as see the exhibition. It was very apparent that the efforts of Claire, Sally, Esther, and the Hull Museums team with the marketing of the exhibition had been vital to making it such a success.

Another important job is to make sure the audience understands what to do. Interactive art is new to many people. Interpretation (the labels, signs and instructions on the walls around the art) takes a while to get right; some places like more, some less, but usually more. We like the idea that the audience discovers things for themselves, but most venues want to help their visitors get the most from the artwork. The colourful interpretation for *Microworld* at Ferens was playful and aimed at youngsters; there was even a spotter's guide handout for children to tick off all the digital creatures they discovered.

Just before an exhibition launch, we talk to the staff about what to expect, any technical issues they may come across (usually kids jumping on sensors) and tips and tricks on how to help people to engage. The front of house staff, volunteers and technicians are another, often overlooked part of an exhibition —the people who make sure things run smoothly on a daily basis. When the installation is completed by the technicians and we have playtested and balanced the interactives, our job is pretty much done. We then hand it over to the local team. We like to say that 'this is your exhibition now' and we mean it. It is up to the venue to engage its audience in whatever way it sees fit, including through the development of public engagement activities. The Ferens Art Gallery really went for it and as a result enjoyed huge audience numbers with *Microworld* and attracted visitors who had never been to the gallery before.

Towards the end of the exhibition, Claire said:

> "It was really exciting to be breaking our visitor target and seeing how popular the digital artwork has been. We weren't sure what the visitor reaction would be like, but our visitors have really embraced it and made multiple visits. However, our success is setting us a challenge to keep programming popular family-friendly exhibitions in the future."

They have just opened a Moomin exhibition *The Wonders of Moominvalley*, and we wish them well with that.

> "We had such an incredible time with this exhibition over the summer. We have loved it and we are so glad to have seen so many people get to enjoy it too!" Ferens Art Gallery visitor

Nicola Schauerman and Tim Pickup

Genetic Moo. *Microworld* at Ferens Art Gallery, Hull (2025)
Photo Ferens Art Gallery, Hull Museums

When is interaction too much?

Sometimes interaction works better when there is less of it. We often explain to venues who typically think they want as much interaction as possible that entering our Microworld spaces is like entering a forest. There are different degrees of interactivity. If you try to interact with a squirrel, it will immediately respond by legging it. If you're lucky, it might come up to you. But if you try to interact with a tree, nothing much happens. It stays put. Or maybe you find a small bubbling brook and build a simple dam with some twigs from the tree, creating a puddle. The idea is that interactions vary: some are tightly coupled (responding immediately), while others unfold more slowly over time. Our *Lichen* piece requires someone to stay still for two minutes to make a mark. And it is the combinations of these different rates of interaction which make a space as a whole feel more like something that is living. Sometimes this slowness can become a better way of engaging an audience. Add some beanbags and you'll find that people sit themselves down and relax, going with the flow and immersing themselves in the small, subtle changes. Psychologists call these sorts of effects 'soft fascinations', like the changing shape of the clouds, or the fluttering of leaves on a tree. They have been shown to have a strong positive effect on human health and wellbeing. This effect is repeated even if it's digital (i.e. not real nature). Which is an extraordinary discovery. Not only are our shows artistic, entertaining and informative, they are also good for your health.

Dwell Time

In the museum world, there is a term called dwell time which refers to how long people stay in front of a particular exhibit on average. Museum curators have to balance different dwell times so that the flow of people through a space works well. For our work, the dwell time may be a few minutes per interactive. This affects what type of programs we can use. We'd love to include Genetic Algorithms or Evolutionary Algorithms in our shows, because they reflect the themes of our art, but these algorithms are too slow to be meaningful to our audience (without a lot of text explanation, which we don't want). We think the audience is happier when they understand what is happening without being told.

Genetic Moo. *Microworld* at Ferens Art Gallery, Hull (2025)

Genetic Moo. Julia interacting with the *Cockatoo Squid* at *Microworld Arcadia*, ArcadeCardiff (2013)

9. I am the Sound Designer / Julia Schauerman

Sound is a key part of making an interactive space feel right.

Julia Schauerman is a successful sound artist and happens to be Nicola's twin sister so it was natural for us to collaborate with her from the outset. Over the years we have developed a variety of approaches to interactive sound design. Our working methods are flexible and we've tried to avoid the situation where sound is "added on at the end". In this chapter Julia shares her perspective as a sound artist working with interactive installations.

My work with Genetic Moo began in 2013 at their ArcadeCardiff exhibition, *Microworld Arcadia*. Nicola and Tim asked me to jam with one of their digital creatures, the *Cockatoo Squid*. The duet started with silence, then the squid called out, I responded with a note on my saxophone. Initially, it was call and response, one would sound whilst the other 'listened', then gradually we began to sound together. It felt like we both had agency.

I also composed a generative soundscape for this exhibition, one that represented the eight stages of a circadian cycle. I created the sounds using a Logic Pro keyboard synthesiser. Each stage consisted of three layers: a drone, a chord and a two to five note riff. The layers were randomised and played using a computer program. Using the percussion sounds of the same synthesiser I also made a series of 'creature' noises which have been used ever since.

Textures and Gestures

I have found the terms texture and gesture, as defined by composer Dennis Smalley when writing for listeners of acousmatic music*, a very helpful way to think about sounds within a sound design. Gesture is the sound as an event or

action, with shape, direction, and momentum. It often feels like a cause-and-effect movement. Texture is the sound as a mass or field, where the listener notices its grain, density, and changing inner behaviour more than its start or finish.

> *Acousmatic music is "characterised by sound produced without a visible source" (Oxford English Dictionary (OED) online); it is composed with recorded and/or transformed sounds, before being presented to audiences using speakers.

Recording

All of my works are composed with recorded sounds. These could be everyday sounds, such as traffic, or pitched-based sounds (instruments). To guarantee good quality I record all my own sounds. I use the H2n Zoom Handy Recorder. I set the recording level at 55% to allow for unexpected increases in volume, thus avoiding distortion. For field recordings, I set the microphone at a 120° angle, and for nearby/specific recordings of, for example, a voice, I set it at a 90° angle. I record in WAV format, which is uncompressed.

Transforming sounds

I mainly work with open source software. The digital audio workstation I use to manipulate, transform and mix sounds is Audacity. It's very user-friendly. In Audacity you apply an effect to the sound in one go. For example, you can reverse a sound. I also use open source synthesisers: PaulStretch, which can stretch or shrink a sound and take it from noise into a tone (the noise of an air conditioner can be transformed into a high pitched drone); and Granulab, which captures your live manipulation of a looping sound (such as varying tempo, pitch, granulation etc).

Live mixing

During lockdown, I worked remotely with Genetic Moo on a series of *Microworld@Home* broadcasts. Each week we would do a 20-minute improvisation: me mixing sounds while they interacted with their digital environment. We would respond to each other and to the evolving

environment. To prepare for these sessions, I would go through my stock of sounds and also record and manipulate new sounds, producing a set of sounds to suit the theme for that week, such as *The Lost Aquarium*. From these I would create an Audacity project with twelve tracks, each 22 minutes in length, ready to live mix with its built-in mixer board. Then, using OBS (Open Broadcaster Software), we would improvise together.

Toward the end of the *Microworld@Home* broadcasts, I improvised with a mix called *Constructing Cities*, made from sounds I had recorded on a Sheffield construction site. As a student at this time, I had access to GRM Tools, licensed software. The GRM Doppler tool, which changes the pitch of a sound to match your movement of it through an audio space, was very productive when applied to the recording of beeps from a reversing vehicle.

This particular broadcast went so well that we used it as the basis of the sound design for an upcoming exhibition in Norway.

Microworld Kristiansand

For this large-scale exhibition and short film I worked with sound in three different ways: a composed film soundtrack, a series of interactive elements, and a welcoming, comfortable soundscape.

1. Film Soundtrack: *Constructing Cities*

The soundtrack had to be tightly coupled with the action in this 13-minute film. I identified which sounds to use for each element and then edited them to fit the action. I watched the film multiple times to get the timings right, a painstaking but necessary process. In the film, robots' footsteps were represented by the sound of hammering. A heavy thud for Tim's robots and a light metallic one for Nicola's. I used a variety of banging sounds to represent pixel boxes, which would drop into place. For the city spires that appeared and expanded I used the sound of church bells, manipulated with PaulStretch giving them a strange, ethereal quality. The composition was carefully built up step by step.

2. Interactive Elements

The same samples were also used as part of the interactive called *SeaPeople*. In the gallery these sounds would be randomised, pitch bent and panned to add variety. This job involved isolating a single sound or taking a short extract from the longer samples. The sounds needed to be 'simple', to avoid the potential cacophony triggered by multi-user engagement. The sounds used for Robots and Pixels were too resonant in the space, so I recorded a two-tone woodblock for the footsteps and recorded myself punching a leather cushion for the falling boxes. The city spires church bell sound was found to be too intense in the gallery, so I was asked to replicate a single peal of the bells using a keyboard.

3. A welcoming, comfortable soundscape.

Genetic Moo also requested an ambient soundscape which would play throughout the space as a backdrop to the interactives. The agreed structure was for four sections called Red, Green, Blue, and Black, each 10 minutes long, which tied in with a colour cycle present in several of the interactives.

I used a recording of a piano and saxophone improvisation as the pitch-based sound source. I thought about what each of the four colours could represent and came up with the following:

Red = soil, Green = growth, Blue = sky and Black = night sky.

I then selected a number of short phrases (between 13-30 seconds) from the improvisation as potential matches. I ran the phrases through the GRM Evolution tool, which creates a continuous evolution of timbre by frequential sampling of the sound. Listening while changing parameters I was able to identify which phrases matched my sense of the colour. Having identified the four phrases to work with, I improvised for 15 minutes with each one in the GRM Evolution tool, which was recorded. This was the first layer of the sound design, known as clouds. The next layer, known as atmosphere, was created by taking the last strains of each cloud track and stretching it in PaulStretch, turning 20 seconds into 10 minutes. Finally, some creature sounds were created by manipulating recordings of handheld instruments. The soundtrack worked well and has been used in many subsequent exhibitions. I

am paid for creating the compositions and for every exhibition in which my sound work is used.

Approaching a sound-design commission

- Good communication is vital: make sure you know what is being asked of you. I want to know the type of environment/world that is planned and how sound will function within the space
- Feedback is essential: be open to it, check you are on the right track. Test as you go to see how sounds combine.
- You won't know until the exhibition is being installed whether the job is complete; changes and adjustments are usual. Be prepared that the sounds may be played through basic equipment and may not be in stereo. Sounds may need to be adapted to match the space.

Tips

- Step outside and listen to the textures and the gestures in the everyday sounds: distant traffic, a plane overhead, a car horn, birdsong.
- Keep all your recordings. I remember Tim asking me to record an old coffee percolator because of its lovely glug-chugging sound. Years later, this became the sound of a sea creature.

Nicola Schauerman. 16mm film loop installation, North East London Polytechnic (1989)

10. I am the Artist: *It's Alive!* / Genetic Moo

Genetic Moo consists of creative coding couple Nicola Schauerman and Tim Pickup. We weren't always making interactive art.

Nicola Schauerman

I started out with filmmaking and fell in love with film as a material rather than as a storytelling technology. On my journey from 16mm installations to interactive art, that love of material gradually shifted to pixels and the audiences themselves, until the "screen" became the whole room responding to the people moving inside it.

I tried everything on my foundation course: photography, performance, video and Super 8. I was fascinated by the physical side of film: the material and the handling of light and time. That's what led me to doing a BA in filmmaking at North East London Polytechnic. We filmed on 16mm, processed the black-and-white negative ourselves, and used an amazing, ramshackle contact printer to produce the positives. I spent hours in the darkroom and the photography department totally absorbed in processing and manipulating the medium. I spent days in the edit suite rearranging shots again and again, more interested in rhythm and texture than narrative, and I kept bumping into the feeling that I wasn't actually interested in telling a story, with a beginning, middle, and end.

Because the course was experimental, I was encouraged to explore other directions. I started making installations with loops of 16mm film running through projectors, stretching thirty feet across a space, casting moving light onto walls and constructed surfaces. This approach to filmmaking sits within "expanded cinema"—moving-image practice that pushes beyond the single-

screen projection to include multiple projections, installations, performance, and other media, often making the audience's experience central to the work.

My installations awoke an earlier interest in halls of mirrors, ghost trains and haunted houses. I was excited by the idea that you moved through the film, your body inside the work rather than sitting in front of it. I started to see audiences as active: walking around, looking around, stitching their own version of the piece together as they moved.

Following a few years of teaching English, I moved back to London in 1999, wanting to get creative again. Video cameras were now very cheap and, even though I still carried the discipline of 16mm in my head, I liked the freedom of just picking up a camera and trying things out.

Finding the screening collective Exploding Cinema was important. Still going strong, their rough, energetic, no-budget, anyone-can-show screenings are generous and open, proving that film doesn't have to be precious, it can be messy, shared and live.

I missed participating in art college tutorials, in particular discussing projects and getting feedback from a peer group. So I put out a flyer at an Exploding Cinema event looking for people to form a film and performance collective. Over the next four years, eight of us skill-shared, made films, music and radio shows, this was the first iteration of Genetic Moo. Tim Pickup was the third person to join, bringing in coding skills and his own interest in using computers to create art.

In 2004, we were invited to put on a show in The Foundry, Old Street. We were given the old bank vault in the basement. The idea was that all involved would create work in response to the show's name, *Powerful Sexual Moments*. My inspiration for this show was a dried starfish, specifically a horned sea star. When I looked at it closely, the bumps and curves started to look like parts of the human body: breasts, knees, bottoms, folds of skin pressed into another form. I made a large, 2m x 2m collage, rebuilding the starfish body using photographic fragments of my own body, at 1:1 scale. It was like nothing I had ever made before, creating a frisson of human and alien, desire and disgust.

Standing in front of it, I realised I wanted it to move, to respond to me as I came close. To do that, I would need new tools: code, sensors, some way of making this starfish creature responsive. I enrolled on an MA at the Lansdown Centre for Electronic Arts at Middlesex University. Tim had studied there a few years earlier.

In the second year of my MA in 2005, I enlisted Tim to help me with the starfish coding to move it on past my simple experiments. We wanted to give the starfish something like a digital metabolism—patterns of behaviour, not just pre-recorded animation. Our collaboration brought my film and installation experience together with Tim's interest in using code to simulate life. The second stage of Genetic Moo began.

After the MA we spent about a year refining its behaviour and how it responded to the audience. Its first outing was in the group exhibition *Electric Blue* curated by Rita Parente in 2008 at the Bargehouse in London.

Looking back, it doesn't feel like I stopped being a filmmaker and became something else. It feels more like my attention slowly widened from a strip of film running through the projector, to the room, to the people in the room, and then to the digital creatures they engaged with. Expanded cinema taught me to think of film as an environment and the audience as part of the work. Interactive art lets me push that further, into systems that genuinely need the audience in order to exist.

Tim Pickup

I couldn't believe my eyes - it was a TV where you could control what was on it. All you had to do was learn the rules of coding and you could start to change the screen-world one pixel at a time.

In 1981, the BBC Micro was launched in the UK and our family got one quite early on. I began to experiment with my own programs aged about 16; by now the computer was in my bedroom. I did have a go at writing a couple of games but what really enthralled me were simple programs which allowed me to follow the activity of hundreds of pixels across the screen. I began to concoct

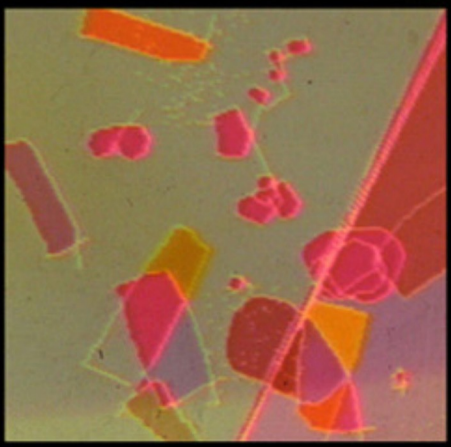
my own little abstract worlds. Using randomness was the key - now the pixels would go their own ways outside of my direct control. With a handful of lines of code I could add pixels to the screen randomly one pixel at a time. I would sit transfixed, past midnight with the lights out watching these silent algorithms go about their work, shuffling around the screen. I'd pick a clear spot and see how long I could last there undisturbed. If a pixel landed on me then I would pick another spot and so on until the entire screen filled up. Which pixels would be safest the longest? How did randomness work on a computer? Were there patterns in the chaos? How were these pixels sucking me into their world?

The high contrast between light pixels and black ground makes each point feel oddly intense, more like a star or a firefly than a speck of paint. Early home-computer games, demos and animations felt vast, because my eyes created a whole world from nearly nothing. This huge imaginative extrapolation is what created a feeling of the sublime. Not the sublime inspired by nature but the sublime inspired by pixels.

Artificial Life

The next step was to zoomorphise them. Endowing them with animal qualities. Building simple systems of behaviour using algorithms. The simpler the better. How simple could these rules be to create a life-likeness? John Conway's cellular automata called *Game of Life,* devised in 1970, was a huge inspiration at the time and has been for generations of coders ever since. Black and white pixels would spread and grow across the screen in ever-changing patterns determined by just a handful of rules. If you could model birth and death with so little code what could you do with more complex algorithms?

There is a whole branch of computer science about this called Artificial Life which studies computer simulations: "not nature as it is, but nature as it could be". One of the appeals of this field is the ability to build worlds and then see what happens. So exciting. I'd made generative artworks and networked games at college, and created amusing toys for websites but hadn't worked out how to project these passions into a physical art space. When Nicola asked me to bring her Starfish to life in pixels and code, I could see a new future mapped out before us. A shared mission.



Tim Pickup. Amiga Genlock experiments, Kingston University (1992)

The *Starfish* and the *Urchin* 2008

A group show at the Bargehouse in London marks our first proper show—the *Starfish* and the *Urchin*. It's a good audience, with only a few running out in disgust. We are now officially interactive artists. Slowly we build our project. Waiting for the technology to get cheaper and smaller and more connected. And we aren't the only ones. Other art groups are probing at the dynamics of this new digital creative age. We start using Processing, a computer language designed by artists for artists. The internet is becoming a useful place for sharing ideas and code. Furtherfield encourages open sourcing and collaboration, Area10 in Peckham allows for no holds barred experimentation. Live-coding is born. We do a show on a tiny Orkney Island for 70 people and the following week at Glastonbury for 200,000. We become resident artists at Exploding Cinema. We play with HKD studios in Margate and their GEEK gaming festivals. We join The London Group as its first 'native' digital artists, but we struggle with how to exhibit in brightly lit spaces alongside paintings and sculptures. For us, it is all about doing it in the dark.

Turn off the lights

Magic happens in a semi-lit space. The pixels themselves need darkness to stand out. Our brain waves change shape and we enter story mode. We like to picture the cave people gathered around a fire at the end of a hard day's work, another hot meal, another day survived. You can imagine the stories of 'hunting and gathering' they would tell each other. We like to think of our art in this context, not as the story, but as the fire itself: a place which allows a sharing of experience.

On being told off

In 2014, looking for some inspiration, we went to a show at the Barbican which included interactive art. It was rare to see such large-scale interactive work back then and we were excited, partly because it used the same Kinect sensors as we had been using. The piece by Chris Milk was called *Treachery of Sanctuary*, a ginormous 30-foot high interactive triptych: "a story of birth, death, and transfiguration" that converted projections of the participants' bodies into a single flapping bird and swarming flocks of birds. An awesome

experience. Unfortunately, not for us. Within about 30 seconds, we were told off for interacting in the wrong way by the bored looking gallery assistant at the back. I guess we were standing in the wrong place, or moving in the wrong way; he didn't specify. But we definitely had to stand behind the line and hold our hands in a crucifix pose, which helped the Kinect to figure out where we were or something. We decided from then on that our interactive art would have no rules, no right way or wrong way to engage. That it would not need anyone at the back telling you what to do, that it would be completely open and intuitive to use. No instructions necessary.

Instructions

On the other hand, we created a torch-driven interactive called *Animacules*. You'd shine the torch onto the blue screen and bizarre micro-organisms appeared as if you were conjuring them from the depths. We asked a friend who had seen it what she thought, and she said, "It's very blue!". We realised she had just been looking at the background colour of the piece; she hadn't even known there was a torch she could use. She had missed the whole piece because there were no instructions.

Benefits of group shows

When you start out, you'll most likely be doing a lot of group shows, which is great. You meet a lot of artists in the same boat as you and have a lot of fun. But you won't necessarily get anywhere. Soon we realised we needed to organise our own group shows. Focus on digital art, get our own equipment—lots of equipment, so we could be in control. We'd dream of a time we could fit our practice on a floppy disc (these days we use USB sticks) as we lugged equipment around the country. We even provided equipment to artists in the group shows too. So much for the weightlessness of digital art.

Everyone gets paid

We've done lots of collaborative projects, organised many group shows, events and festivals, and we have a rule that every artist gets paid. Even when we've only been paid a small amount, we try to spread it around. For our first show, it was £20 each for the artists, musicians, even the first-timers. At least it's

something. The same is true when we've been funded. We have had ACE funding three times and these were helpful chunks of money in the early days. But we don't do it a lot and we certainly don't rely on it, though they do seem to like our type of art: it's digital (tick), engaging to the public (tick), inclusive (tick). So we're thankful for what they've given us.

Going up the ladder

Around 2012, an art group from Japan was beginning to make ripples in the digital art world. TeamLab would go on to become the biggest interactive art group in the world. We'd seen bits and pieces of their project which was taking over entire museums. TeamLab currently employs more than 500 people and has started building their own galleries. The one in Tokyo has 470 projectors!

One of the fantastic things about digital art is that it is scalable. The same piece can run on mobile phones or it can run on huge screens. We once showed a piece at ISEA 2016 Hong Kong on the colossal Open Sky Gallery, one of the largest media screens on Earth which wraps the 118-storey ICC Tower. The resolution is roughly 60 by 118 'pixels', making this both the lowest resolution and the largest artwork we'd ever done.

In the 2010s, venues were starting to provide their own projectors and we could begin to think about more ambitious projects. We knew that we didn't want to go the TeamLab route, really we weren't capable of it. We didn't want the responsibility of employing other people. So it was fortunate that working with a producer on commissions has worked out well and enabled us to do several large projects most years.

In our head we have a 1–5 ladder of success. Which goes like this:

Level 1 – you pay for your own shows. Your friends attend your shows. You attend theirs. We once paid £250 for a small group show in the Brick Lane area along with about 5 other artists. It was a trendy area with lots of interesting art shows dotted around. Nobody came.

Level 2 – you get paid to put on shows, but not much. Enough to buy more equipment. You make more contacts. Attend more festivals. Some of our early

shows might pay us a small fee, say £300. Once you've paid for the artwork, the travel to get the equipment there, and a night's Airbnb so you can do the install and attend the private view, you're basically making nothing, breaking even. Still that's a new audience and another experience.

Nicola has pointed out there are a lot more steps in here, and we were at Level 2 for many years. There are occasional large commissions, and then there's nothing much for a while, or a series of underpaid workshops. But you continue to build up experience. Somewhere in here we did 13 shows in 3 months with, on one occasion, 4 shows running simultaneously. We still did most of our own installations. We were at the stage of our career where we couldn't say "no". We were keen to learn new ways of showing our work and meet new people and try out new venues. We now look back on these opportunities as our 'shrimpers', small but vital catches. They were part of an important learning stage in the development of our work. Eventually, we secured enough well-paid opportunities to advance to the next level.

Level 3 – you are paid a reasonable amount for your shows. You can quit your other jobs and focus all your energy on being an artist. Over several years we honed our art, improved our messaging, and created some successful shows which left us, the venue and the audience happy. We could see by now that there was a real appetite for art made using technology. And alongside that a large audience out there which wasn't that bothered by the traditional art world. Many had never been to an art show before. Or seen interactive art before. Our shows tend to be in regional museums or gallery-museums rather than art venues. By this stage, other people are doing the installations for us, and doing them better than we could.

Level 4 – you are paid a lot for your shows. You employ a team to make your art, anything is possible. You are written about in art journals and glossy magazines. Festivals and art galleries desire your shows. You charge entrance fees. UVA and Marshmallow Laser Feast are around this level.

Level 5 – you have an international team. You are stratospheric. You are so big you can build your own art galleries. TeamLab is at Level 5, the greatest interactive artists in the world.

We consider that we are at about level 3 and a bit. We're not sure we need to go much higher, or if we even could. It'd be nice to be written about more and have more peer acclaim, and be contacted by big local art venues to do something with them, but we are happy at this level, it is within our control, we work with good people and we have tons of ideas and space to try them out. The aim was always to spend all our time doing what we loved to do which is create art and see audiences enjoying our art. And we have achieved that. What we don't love to do is admin but we accept it as part of the job. However much you try to avoid it there is always some admin to do—things to explain, instructions to give, social media to keep ticking over.

Numbers

To dig into the numbers a bit more let's look at a typical commission, which for us would include an artist fee of about £10,000. If we do 4 shows like this per year then we have made a small living. Enough to cover our rent in Margate and keep us happy. What else do we need, not much: lots of equipment, new tech gadgets to play with, books for research, etc.

So what does the venue get for this amount? This would cover a 4-6 projection show running for 3 months, with some bespoke material. Often our shows are summer shows as kids and families are a natural audience for our art. In addition the venue would need to pay the producers and the technicians who install and maintain the show. It is hard to give these amounts because it depends on the venue itself and what equipment they have. Do they need to buy or hire projectors? Black-out windows, Install new walls? All these things can be done but they add cost. At a guess the venue might have to spend £30–40K in total for our type of show which can attract big audiences if promoted and supported well. They need to put on a range of shows over the year and they will have a fixed total budget for this (we've noticed these have been shrinking in recent years and the fees are being squeezed and the shows are getting longer). Some shows are cheaper and some shows are more expensive. We are often rubbing shoulders with Lego shows or Wildlife Photographer of the Year which cost less to put on and are always popular. The venues are doing their best by their audiences with a variety of offers.

Visitor numbers

You won't get commissions unless you have a proven track record of popularity and reliability. Building relationships with potential commissioners is key, which is why having a producer is really helpful. We prefer our shows to be free to the public, but this isn't always possible, some venues have to charge. Our producer works with the venues to secure a good artist fee, while making sure the technicians and other workers get paid properly too. Equipment may need to be hired or purchased. One way to give confidence is by showing how popular our shows have been, so we keep track of visitor numbers.

The North

We have put on many large shows since lockdown, here are the last 11 UK venues: Carlisle, Leicester, Lincoln, Tunbridge Wells, Wolverhampton, Halifax, Cumbria, South Shields, Coventry, Tunbridge Wells (again), Halifax (again). Can you see a pattern? We get a lot of our work in the Midlands and the North. We have a makeshift theory about this: these regional museums and galleries are more experimental in their selections, perhaps more willing to take on digital art, or maybe they talk more to each other up North. Take this as a piece of advice, there are museums up and down the country. Do not limit yourself to London. We've hardly done any shows there.

Be nice

Enjoy what you do, and be enjoyable to work with. We can't tell you how many times we've met technicians with horror stories about working with difficult artists. We don't know who these people are but there must be a lot of them walking around, because we've rarely met a technician who isn't wary of artists. There's often a 'getting the measure of each other' phase when the technician figures out how much pain we are about to inflict upon them. We aim to be as flexible as possible. There are usually several different ways of solving any tech issue, and it is best to lean into their knowledge of their building. Remember after the install the show is theirs to do with as they want. Everyone wants the show to be a positive experience.

Genetic Moo. *Microworld* at Ferens Art Gallery, Hull (2025)

11. I am the Artist: *Microworld* / Genetic Moo

So let's wind back the clock to when we started to put together the *Microworld* idea. After a few years working on a series of group shows, we had gathered a small collection of creatures. We figured that if we put several pieces together the audience would move from one to the other. Trying different ways of interacting—different ways of exploring a space. The whole show would become more than the sum of its parts. A world of activity would emerge. The *Microworld* concept was born. This was our path to scaling up.

Modularity

The key for us is to make the shows modular so they can fit any sized venue. It gives curators options, and it allows the audience to explore.

We keep our technology as low-fi as possible (i.e. everyday and readily available equipment) and make sure we choose components that are happy to talk to each other. We use simple affordable sensors. Pretty much all our artworks use the same set up: one computer, one sensor and one projector. Crucially this makes installations logical for the technicians. Even if there are metres of cabling running underground, or through false panels or up walls or running along trusses in the ceiling, there is still just one cable from the sensor to the computer (usually USB) and one cable from the computer to the projector (usually HDMI). We also run all our programs at the same screen resolution 1280x720p. All our programs are written in Processing. This means that we can swap around which program goes where during installation. This is important because it is difficult to know exactly how a space will feel until you're physically in it. It gives us flexibility.

Microworld: the name

In the 70s–80s before various branches of computer science became dominant, people wrote their own computer programs to explore simulated

worlds or 'Microworlds', as they were briefly called. For example, the Logo programming language where kids could make a robot turtle navigate intuitively across the floor was referred to as a Microworld, as was SHRDLU an early AI program which moved blocks around a virtual table in response to conversational requests. We like these early simulations.

We had also seen a BBC2 documentary series called Nature's Microworlds. Each episode explored a different ecosystem - the Serengeti, a kelp forest, the Scottish Highlands, and so on. It examined the flora and fauna living there and mapped the interlinked chains of existence before finally revealing the one or two keystone species which, if removed, would cause that particular ecosystem to collapse. In the Amazon it was a hummingbird, in Yellowstone it was wolves, you just couldn't tell. We wanted these types of linkages in our interactive spaces. Just like we had explored with Sean Clark back in the exhibition *Symbiotic*. And to get more linkages we had to do bigger shows.

Using this modular approach, we ran two large shows at the same time, both called *Microworld*, and entirely different to each other. They crystallised how our project could work. *Microworld Brecon* and *Microworld Eureka!* These laid the foundation for all our subsequent shows.

Microworld Brecon 2018

In 2018, keen to do something digital with her community, Carla Rapoport linked up with her local centre for the arts, Theatr Brycheiniog, and brought our *Microworld* project to Brecon. We scheduled the first week to coincide with a half-term holiday so we could run daily creative coding workshops. Our creature-making programs ran on laptops enabling us to generate loads of new creatures together. 70 people got involved from school kids to seniors, all making digital creatures and geometric animations which we added into the multiple projections around the gallery space almost instantly. It was a big hit, people loved making over the space. The show ran for a month with people coming back to see their contribution. We also added some of our own creatures; *Mother, Multiple* and *Maggots*.

Superorganism

On the way home from the show, we thought of a better name for this type of show: *Superorganism*. A large thing made up of lots of smaller things. In nature an ant nest is a good example of a superorganism. For years we taught this concept and ran workshops in colleges, schools, libraries and festivals. We loved making tools that allowed people to make creatures. Even better was to display their creations, giving them a real sense of pride in what they'd made.

We do less of this now because the budgets for educational add-ons have been squeezed and they need a lot of personal support and also, to be frank, Tim got pretty tired of teaching kids how to draw a green rectangle for the thousandth time. We decided to focus more energy on bigger, longer-lasting shows and we simplified the creature makers so they could be done without instructions on touchscreens. People could teach themselves.

Microworld Eureka! 2018

This had 5 projections spread around a 25 sqm space with 3 touchscreens in the middle. It was the first project we did where we could feel the ecosystem energy. Eureka! is the National Children's Museum in Halifax and the footfall is huge—thousands of people week in, week out. This 6-month show was attended by over 100,000 people. The public loved it. The room looked great. The technology was stable (apart from a sweltering summer weekend where several PCs got too hot and gave up the ghost). The enablers were brilliant and seemed to enjoy the space too. The public was generating thousands of creatures. Pieces were responding to each other across the room. It was exciting, you felt like you were inside a living digital system—a proper Microworld. We felt proud. We wanted to do more.

Ecosystems

Once we started combining several responsive projections, the space became an ecosystem.

> In biology, an ecosystem is a system formed by organisms interacting with their environment. The biotic and abiotic components are linked together through nutrient cycles and energy flows.

When you start researching ecosystems you come across various roles that different species occupy such as primary producers, herbivores, carnivores, apex predators, decomposers, parasites, indicator species, and keystone species, and we have designed creatures to play all of these parts in a fairly abstract way. For example, in *Squidlets* when a Squidlet dies, it falls to the bottom of the screen and turns into a pile of pixels. This is where the Termites live. They look around and pick up the coloured pixels and sort them into types, building small mounds which get bigger as more Squidlets die. This form of decomposition generates a record of the day's activities.

Biodiversity is another topic that can be well illustrated by an ecosystem approach. By adding more creatures with different behaviours into the same screen we generate thriving communities at play. We can even start experimenting with population dynamics: do more species make a system more or less stable?

The first rule of ecosystems is that everything is connected to everything else And that connection is a form of interaction. You can start to see the hidden potentials of interactive art to explore our place in nature.

> "Everywhere in the world there are places of encounter where substances react, bonds form, electrons jump from their shells into those of other molecules, where massy bodies begin to attract one another, so from the stories of individual participants, new situations emerge that are always brought forth mutually by all the participants."
>
> *Matter and Desire: An Erotic Ecology.* Andreas Weber. (2017)

We see interaction between bodies as an endlessly fascinating topic. Bodies, agents, agency, life.

Sex

Can our creatures reproduce? Occasionally but it happens in odd ways. For example, if *Aeroplankton,* which are geometric creatures formed by sound waves, hear enough of their birth frequency, they grow bigger until they reach 300 pixels in size, at which point they split in half, each child taking on a mutated variation of the parent's appearance. This type of reproduction might be familiar to bacteria. Other creatures have different strategies; for example,

maggots in *It's Alive!* breed if they get enough food—a certain colour on the screen. But this does lead to issues. What happens if there is so much food that more and more maggots appear, taking over the whole screen? Eventually they will have eaten all the food at which point the maggots will die off. So there is a natural wave of population increase and decrease. When there are 1000s of maggots the program itself slows down and we accept this unevenness because it reflects the state of the system.

Consumption

We also create systems where one species eats another. Or more accurately one set of algorithmic processes is predatory on another. By coupling systems together in this way we can start to see complex waves of activity, without having put in any specific narratives. Because the audience is also another random (or unpredictable) factor and can either attract, repel, birth or destroy other systems: the whole world is chaotic and richly variable. Some interactions between creatures are one-sided, others mutual, others are parasitic. We look for terms in biology which describe animal behaviour and try to reference these in small ways. We do this so that there is always something going on. Always something for the audience to interpret.

Stewardship

We came to realise that our shows also encouraged people to look after the system as a whole and be creative within it. Or perhaps subvert it, or experiment with it. It all counts. Stephan Harding, a zoologist and specialist in Gaia theory, once said to us that we risked making our *Microworlds* more appealing than nature. Our shows are about nature, but they are not the same as being in nature. Stephan was worried about technology keeping us from nature. However we don't see this as a problem and if humans stay away from nature for a time and let it repair itself this may not be such a bad thing. We see encouraging a sense of stewardship as a good skill for people to learn and hopefully apply across their life both on screen and off.

E. O. Wilson, the renowned biologist, used the term Biophilia to describe humans' inherent love for natural things. We also use this term, applying it to

digital nature. By simulating complex ecosystems, and inviting playful exploration, we encourage empathy for nonhuman artificial life.

Dance of Agency

As interactive artists, our creative process is fundamentally shaped by a dance of agency: a dynamic interplay between ourselves (the artists), our audiences, and the technologies we employ. Our works are not static objects but living systems, continually evolving as people engage with them.

Each interaction is a moment of feedback and adaptation. When viewers touch, move, or respond to our installations, the work itself changes, and this in turn changes what they do next.

The audience becomes a co-creator. We never know exactly what they'll do. We watch them, and this leads to refinements or even new ideas. This dynamic interplay gives interactive art a unique vitality and relevance.

A Hopeful Ecosystem

We are developing new show ideas all the time. We want to give the audience even more agency. We want them to be able to control everything. To rewild the world. To create creatures that take over the entire gallery space, migrating from one screen to the next, consuming all available food and then dying out for lack of something more to eat. Then new, dormant creatures, seeds and plants will burst into life, growing into the ecological niches left behind by the previous hosts. We don't think this type of show has ever been done and we don't know technically how to do it yet (how do we fit it all in?) but we can't wait to try and figure it out.

Genetic Moo. *Growthlines* at Papey Listskjul, Orkney (2011)

Genetic Moo. *Bloodworm* (2026)

12. CASE STUDY 1: *Bloodworm* / Genetic Moo

In this chapter, we're going to teach you how to make a piece of interactive art. You can connect it to the TV in your living room. Like all our works it will use one computer, one sensor and one screen. We call it Bloodworm.

We use Processing. You can download it at processing.org. It is free, open source and easy to learn. It has been around since 2001 and is very stable, thousands of artists have built up the language by adding useful libraries and code examples. Again all free. We still use version 3.5.4 which is rock solid. One of the great things about Processing is that you can copy a project from a PC running Windows to a PC running macOS and it will just work the first time, no need for any changes. This is great because we use both types of machine, depending on the sensors we're using. Sometimes venues provide computers or interactive kiosks, and 99% of the time it will run on them too. We just feel very warmly towards Processing and its entire community, and have been using it for over 10 years. They have created a sister language p5.js which runs in browsers and we sometimes use that too, especially if we want to do networked pieces.

We're going to use p5.js for this example because it runs in a browser and there's less to set up, but we thoroughly recommend downloading Processing too and working your way through all the free examples on their website.

So let's think about sensors. We often use Kinect sensors and these are available cheaply secondhand but Kinect is a little bit fiddly to get working on newer machines because it is an older technology and it doesn't work with browsers. So we're going to use a webcam. Your laptop should have one built in. If not, connect a USB webcam to your computer. These are also cheaply available on eBay.

Now we need to go to the p5.js editor
https://editor.p5js.org/
You can create an account for yourself or just start typing.

You get some code for free:

```
1  function setup() {
2    createCanvas(640, 480);
3  }
4
5  function draw() {
6    background(200,200,200);
7  }
```

There are two functions. Functions are the basic building blocks of coding and each function has a special purpose. The **setup( )** function happens once when the program runs; the **draw( )** function loops endlessly until the program stops. Press the big **PLAY** button at the top to run the program, and the **STOP** button to stop it. Coding in essence is simple: write some code, run it and see what happens, stop the program, write some more. Keep going until you are happy with what you have made.

If you write something the computer can't understand or you miss out some punctuation, then the program won't run, and you'll get a red error message below your program, which should help you to see where you went wrong. You may even see which line contains the bug: the mistake you made. Try and fix it. This process is called debugging and every programmer does a lot of it.

When you run the program above, a grey window will appear. This is the canvas which will contain your interactive artwork. Try changing the numbers in line 6 **background(200,200,200)**, for a blood red canvas change the numbers to **background(200,0,0)**.

So let's get the camera working. We need to write a few lines to set up the camera and to get the image from the camera. Your new program should look like this.

```
1   var cam;
2
3   function setup() {
4     createCanvas(640, 480);
5     cam = createCapture(VIDEO);
6     cam.size(640, 480);
7     cam.hide();
8   }
9
10  function draw() {
11
12    image(cam, 0, 0);
13
14  }
```

And, if you want to try a more artistic effect, add **tint(255,10);** on line 11.

Now we're going to create lots of worms and make them crawl across the image. Whenever we create a lot of something it's a good idea to build a class which contains the description of how the thing moves, where it is on the screen and how to draw it. This way, we don't need to move each worm individually, we move them all together. We are generalising the worm behaviour. The worms have a similar style but they are all in different places.

Here's how to make a class called worms:

```
var worms = [];

function setup() {
  createCanvas(640, 480);
}

function draw() {
  background(0, 5);

  // add new bloodworms
  for(var i=0; i<10; i++) {
    worms.push({
      x: random(100, 540),
      y: random(100, 380),
      vx: random(-2, 2),
      vy: random(-2, 2),
      life: 255
    });
  }

  //move and draw each worm
  for(var i=worms.length-1; i>=0; i--){
    var b = worms[i];

    //wander randomly
    b.x += b.vx + random(-1, 1);
    b.y += b.vy + random(-1, 1);
    b.vx += 0.2 * random(-1, 1);
    b.vy += 0.2 * random(-1, 1);

    //age
```

```
32        b.life -= 5;
33
34        //remove dead ones
35        if(b.life <= 0){
36          worms.splice(i, 1);
37          continue;
38        }
39
40        //draw
41        fill(200, 0, 0);
42        noStroke();
43        ellipse(b.x, b.y, 6, 6);
44      }
45    }
```

The worm's head is drawn as a single red dot. Then, rather than drawing all the other body segments, we just fade the whole screen a bit and then draw the head as a red dot in its new position. This way we create the effect of a worm which fades from head to tail. We love this sort of code; it is elegant and quick. It couldn't get much simpler and it creates the effect we want.

Now we have worms and webcam imagery, we can combine these two sets of functions. Combining functions together is the key to building complex and rich programs. You can use the same functions again and again, or adapt them each time. The art of coding is really the art of recycling code, both yours and other people's. One of the great things about computer programmers is how generous they are, they love to show off their ideas and they want you to take them and make something amazing.

Bloodworms has under 60 lines of code. A typical Genetic Moo interactive artwork might have 600 or 6000, but each one is made up of functions like these; just lots more of them.

Here's the final program:

```
1   var cam;
2   var worms = [];
3
4   function setup() {
5     createCanvas(640, 480);
6     cam = createCapture(VIDEO);
7     cam.size(640, 480);
8     cam.hide();
9   }
10
11  function draw() {
12    cam.loadPixels();
13
14    //start new worms in dark areas
15    for(var x = 100; x < 540; x++) {
16      for(var y = 100; y < 380; y++) {
17        var p = (x + y * 640) * 4;
18        var rc = cam.pixels[p+0];
19        var gc = cam.pixels[p+1];
20        var bc = cam.pixels[p+2];
21        var sum = rc + gc + bc;
22        var prob = exp(-7 - 0.01 * sum);
23        if(random(0,1) < prob){
24          worms.push({
25            x: x, y: y,
26            vx: random(-2, 2), vy: random(-2, 2),
27            life: 255,
28            r: 200, g: 50, b: 50
29          });
30        }
```

```
31        }
32      }
33
34      tint(255,200,200,20);
35      image(cam,0,0)
36
37      //worms
38      for(var i = worms.length - 1; i >= 0; i--) {
39        var b = worms[i];
40
41        //wander randomly
42        b.x += b.vx + random(-1, 1);
43        b.y += b.vy + random(-1, 1);
44        b.vx += 0.2 * random(-1, 1);
45        b.vy += 0.2 * random(-1, 1);
46
47        //age
48        b.life -= 5;
49
50        //remove dead ones
51        if(b.life < 0) {
52          worms.splice(i, 1);
53          continue;
54        }
55
56        //draw
57        fill(b.r, b.g, b.b);
58        noStroke();
59        ellipse(b.x, b.y, 6, 6);
60      }
61    }
```

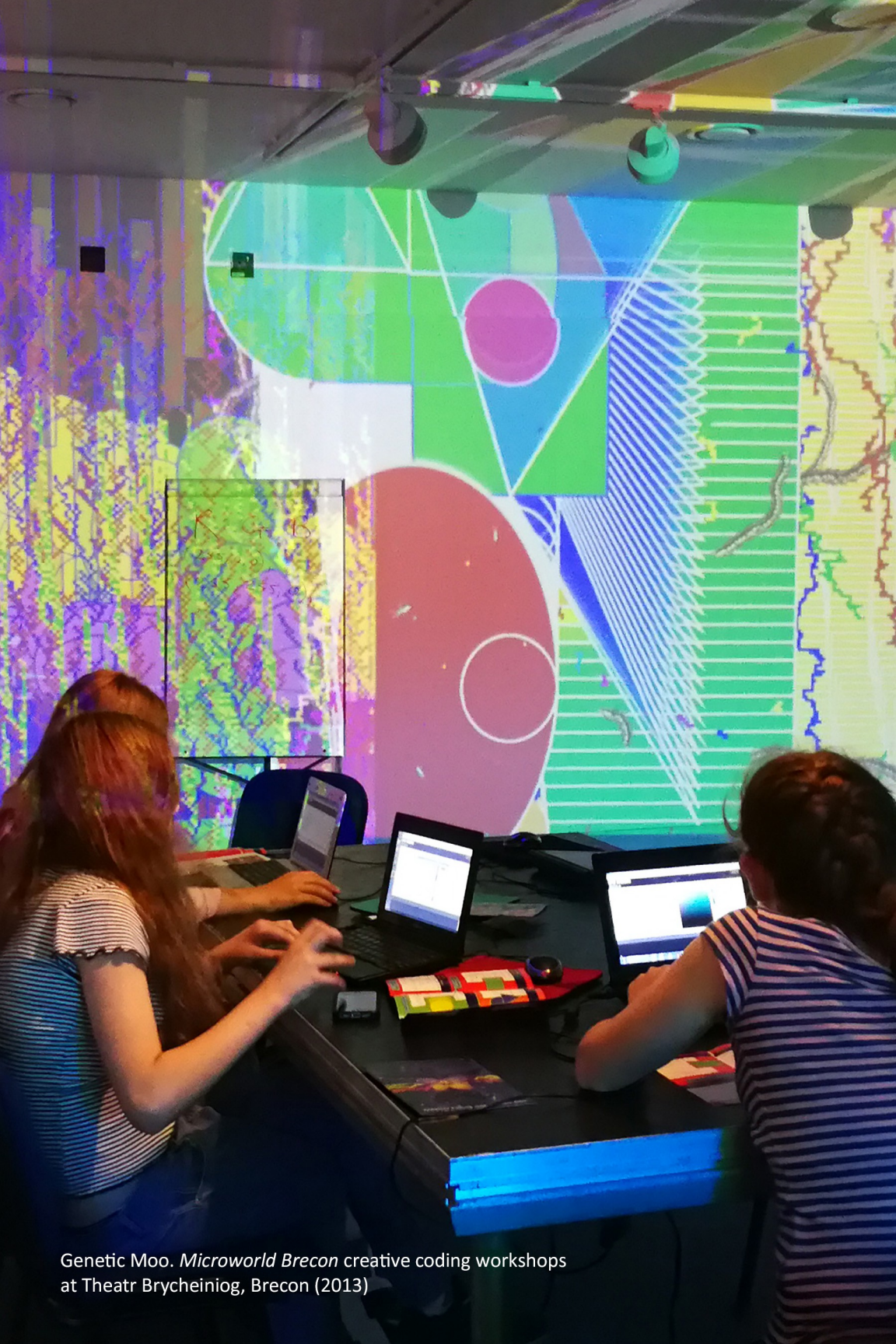
Workshops

Over the years we have delivered dozens of workshops to hundreds of people of all ages. Typically we introduce the Processing language and show how easy it is to get going with coding. And because all our artworks are also made using the same language it's easy for people to see how far you can take it. We might get them to code simple geometric patterns or animating creatures. The best type of workshop is when we teach people to make something that can be exhibited at a later date or even on the spot. All the contributions can be copied into a miniature coded world where they can interact with each other. We used this approach in Brecon. For longer workshops we try to think of a theme which relates to both nature and coding such as recursion or flow, or swarming. In 2024, we ran workshops in Carlisle where people designed their own creatures and gave them synthesised mating calls. We brought all 60 creatures together in a large, generative piece for an ecology-themed show.

Coding is powerful and it can be empowering to take creative control of a computer. It's even better when your creation is added into a public show and you can invite your friends and family to see what you made. We like to engage with the public in as many ways as possible and workshops are a good way to do this. We want to inspire future generations of digital artists.

If you want to run coding workshops, then, practically speaking, you're going to need a lot of netbooks, because coding on a phone or tablet is difficult (too much typing and punctuation to get right). Sometimes, if you're lucky, an organisation will have access to a computer lab or studio. Older kids and adults interested in coding usually have their own laptop. You should be paid for workshops at standard artist day rates. Usually the educational budget and exhibition production budget are separate pots of money, so it is possible to combine both and make a really interesting and unique show.

We always start our workshops by telling people that computers are dumb, they will do whatever you tell them to do. Even though these days computers are showing some signs of intelligence and "the hottest new programming language is English", we still feel teaching old style procedural, line-by-line coding is worthwhile. As they say in the business "program or be programmed".



Genetic Moo. *Microworld Brecon* creative coding workshops
at Theatr Brycheiniog, Brecon (2013)

Genetic Moo. *Multiple* at Limbo Art Space, Margate (2015)
Capturing animation sequences

13. CASE STUDY 2: *Multiple* / Genetic Moo

We call *Multiple* the "the piece that keeps on giving", it is the piece we have shown the most times in the most variations. It has been in almost every *Microworld*.

This piece had an unusual starting point. We were part of a small group of artists commissioned by Animate Projects to work with scientists to make short animated films. There were 6 artists and 6 scientists and the pairings were worked out through a speed dating night. We got together with Dr Neil Dufton and our challenge was to make a film about his speciality: inflammation. After getting a better understanding of the science, we set about creating an interactive program which illustrated cellular multiplication as a key phase of inflammation. The program multiplied the users' silhouettes across the screen. We paid dancers, circus performers and friends to interact with it, capturing short sequences of animation. This all worked well and the film was made. Halfway through the project we realised the piece was so mesmeric and flowing it would make a great interactive in itself, without the medical framing, and this became *Multiple*, one of our favourite and most intuitive pieces.

Because *Multiple* is so customisable, we like to adapt it each time we show it to fit the venue's themes. So we have populated it with moths, butterflies and other local fauna, including wolves and lions. It has been doubled-up and reflected. It has been used as a backdrop for theatre, a fashion-pattern generator and a CD cover. It has been made more (and less) colourful, more geometric, more fine-artsy, more fluid, more knitting-patterny, more Scandinavian and more danceable … One edition saw it taken over by Algae day by day in a year-long exhibition near Lake Windermere.

This adaptive process applies to many of our pieces. Indeed, adaptability is one of the great strengths of digital art. None of our pieces are fixed. It gives us great satisfaction to rework our shows for different venues. Each show is different. We can experiment. We can test out new pieces within a larger show and gather data. We can see what works and what new ideas are suggested. This is how we've pushed the project forward, increasing the range of pieces available and learning as we go.

Art-speak

Because we put so much focus on engagement, we have spent less time writing about our art, which is another reason we jumped at the chance to do this book. When we do write for interpretation and websites we try to avoid complex language. Each label might have 50 words of explanation stuck on the wall somewhere. For example for *Multiple*:

"Multiply yourself across the screen in organic patterns inspired by plant growth, weather cycles and cell division. When you leave the space, the animals continue the dance."

However, we know that there are more complex ways of analysing the pieces, and one way we like to approach this is to combine writing about algorithms with writing about humans. Explaining how we do what we do, and why.

So for *Multiple* this would go something like this:

We want people to be converted into a coloured silhouette which then multiplies across the wall in a variety of formations. By using Kinect sensors we can get an Infra-red image of the audience. The sensor pings out infra-red light which bounces off anything physical and back to the camera and we get a picture of where the solid stuff is. This could be a human, a handbag, a dog, a wheelchair. We then need to convert this into an outline. One way to do this is by using a Moore–Neighbor tracing algorithm. The algorithm extracts the contour of a shape by walking around its boundary one pixel at a time. Starting from a known boundary pixel and given an initial direction, it repeatedly inspects the eight neighbours (the Moore Neighborhood) around the current pixel in a fixed order, always turning as far left as possible while remaining on

the object. Each visited boundary pixel is recorded in sequence, forming a closed loop. The process stops when the walk returns to the starting pixel with the original incoming direction, yielding an ordered list of contour pixels that approximates the shape's outline. Then we take every 10th point from this list and store these as a series of [x,y] coordinates. Now we can draw the silhouette using the PShape() functions in Processing. We can fill this in any colour we like.

For *Multiple* we need a series of staggered silhouettes in different colours and positions around the screen. So we store each frame and shunt through the store showing the most recent ones on top. The current position is surrounded by older shapes.

Since 2023, we've been adding animations of creatures into the program. For Wolverhampton Art Museum, it was wolves. As the humans left the frame the wolves would walk in and be multiplied into a pack. When the humans came back the wolves quickly departed. In this way the humans and wolves hug the boundary between each other.

In fact, the piece as a whole can be analysed as a nested hugging chain. The algorithmic pixels hug around the contours, the geometric silhouettes hug around each other, the humans and wolves hug the ecosystem. *Multiple* itself is one of our most intuitive pieces and one of the most likely to inspire a flow state. We have seen people move and dance for many minutes in front of the piece, and we have done so ourselves for years. *Multiple* has this effect. It is as if you are being hugged by the interaction, held in time and place.

Genetic Moo. *Magic Place* at Eureka! Halifax (2026)

14. I am the Artist: *Magic Place* / Genetic Moo

Magic Place was born of watching kids interact with a piece in *Microworld* called *Sticky*. This involved hundreds of snail shells falling down the screen with varying degrees of stickiness. We watched kids run into the piece, bash a shell, do a crazy dance and then rush out to the next piece. Again and again. Most of our pieces had been designed for focused engagement: a mix of interaction and contemplation, sense and aesthetics. But here the younger kids were going wild. We decided to design a piece which would tap into this creative energy. A space of pure interaction, motion and fun. Aimed at younger kids but with something for all ages. The cheesy but suitable name came about because a 6-year old girl couldn't remember the show's name *Microworld* and instead called it the "Magic Place". And, with a nod to Myron Krueger's *Videoplace*, *Magic Place* was born.

It was quick to develop. We wanted all these small interactive levels and Nicola designed an Emoji interface which was intuitive to use, a flick of the hand changing the action. Then it was just a matter of designing the levels, currently there are about 100. This was a case of throwing the kitchen sink at it and including as many references to early home computing, video games, electronic pop music, early internet, the kinds of technologies around in the 70s, 80s and 90s which we ourselves grew up with. Pacman, Human League, Binatone, 8-bit colour, Q-bert!, modems, Minesweeper, Rubik's Cubes, and on and on, anything we could think of. Trying to capture the magic our generation felt about the possibilities of the new digital age. The levels double up or treble up in layered combinations, making "a million ways to play". That's the tagline.

Bespoking

The piece also lends itself to bespoking. We work mainly in regional museums and typically they have these incredible collections—part of our cultural heritage. Venues love it if you can include something from their collection within an interactive artwork. We've done this in different ways by physically putting their artefacts next to the art works, or incorporating video, photos and 3D scans of items. Sometimes we've even created new works inspired by

objects like the Dudley Bug, a fossil trilobite famous in the West Midlands. These days, we automatically add digitised images of objects from a host's collections into most pieces in a show. This gives the venue a great way to hook the interactive show into their museum as a whole, creating paths between rooms and spotter's trails and other types of audience engagements.

Fun

An essay called 'A study in play, pleasure and interaction design' by Brigid Costello and Ernest Edmonds, lists thirteen pleasures in interactive artworks: Creation, Exploration, Discovery, Difficulty, Competition, Danger, Captivation, Physical Sensation, Sympathy, Simulation, Fantasy, Camaraderie, and Subversion. They note their list is not exhaustive. Our art hits many of these and we'd add the following more experiential states : flow, body sense, being, performance and agency. But with *Magic Place*, the main pursuit is fun.

Art & Entertainment

Are we artists or are we entertainers? Even children's entertainers! Initially, we saw ourselves as a pair of technicians designing fun experiences for others. But as time has gone on we have become more comfortable with the title 'artist'. We happily call ourselves 'interactive artists' and there aren't that many of those around. Some people don't consider what we do as art. Not proper art. We don't spend time thinking about this—we're too busy making stuff, engaging people and trying to figure out how to take this further. It's a huge challenge. We want to engage everyone in some way: the active ones, the passive ones, the resistant ones who won't interact, the creative ones, the ones who want to dance, the collaborators, the subversives, the shy ones, and all those watching from the sidelines. Each show is an artwork, but it also acts as an arena for social play and performance. If this sounds like we're thinking about the audience too much, and we should just be making whatever we want, then this type of art is not for you. To make successful interactive art you have to think outside of yourself.

Flow

Time goes quickly when you are having fun.

All artists will have experienced this. When they are making their art they can go into a special conscious state where they are at one with the art, their tools become extensions of their bodies, they become art making things. It is one of the best feelings in the world. This state is sometimes referred to as "flow". Easier examples: a jazz musician, a footballer. At their moment of creation, playing a tune, kicking a football, the body takes over from the mind, they become one with their instrument or football, and thinking just gets in the way, they release themselves to the greater 'gods' of music or sport to just 'be' in the moment. And a string of these moments becomes a flow. Time drops away. Your actions are intuitive, nimble, fleet. You can excel. The achievement of flow can apply to any human activity including making art, and most artists will have a sense of the amazing things they can achieve when in this state. But your audience can achieve flow too. Perhaps not as much with a painting but when experiencing interactive art it is absolutely possible to get into this state, and we have experienced it ourselves many times. The sense of being present in the moment is particularly strong with interactive art. In fact it is one of its biggest selling points.

Play

BYTE, one of the first computer magazines, launched in 1975 with the cover line: "Computers—The world's greatest toy!" We think this is still true today. Each day we play with this toy, trying to create weird and wonderful things, including art. Making the art itself becomes a kind of play. You tell the computer to do something, it does something else, you iterate back and forth, trying things out, improvising, randomizing, hacking and playing. In Genetic Moo, we play together, we try one thing after another until something works. A playful process. Getting other people to play with our art seems a natural extension of this process. We play, let others play too.

But why do humans play? Founder of the National Institute for Play, Stuart Brown describes play as "preconscious and preverbal—it arises out of ancient biological structures that existed before our consciousness or our ability to speak", the idea being that play prepares animals for a world which continuously presents new challenges. When playing we can try out some 'made-up possibilities' and learn new skills and tactics without being directly at

risk from real life. Here's a quote from Brian Eno who considers play as a precursor to art:

> "We all know that children learn through playing. Everybody understands that when kids are doing things like tipping liquid out of cups and playing with stones and building things and singing songs and so on .... we know that that's all part of their way of coming to understand the world. Nobody says 'why are those children wasting their time doing that? Why don't they do something useful?' You know that that's what children have to do. That's their way of becoming acquainted with reality. Children learn through play ..... and adults play through art".
>
> *What Art Does: An Unfinished Theory* (2025)

Less thinking, more doing

When experiencing a traditional piece of art in a gallery, a large part of the experience is based on how good your knowledge of art history is. With interactive art you don't need that, in fact, it gets in the way; you are in the interaction and your experience is as direct as being in a living space which responds to you as you respond to it. Less thinking, more doing and a large part of this doing is playing. Which is also why kids respond so well to interactive art, they don't need to be told what to do, they don't want to be told what to do—they figure it out for themselves. They play. And when they play they are using their agency. The ability to act.

Agency

When we make art we are designing a system in which the user can play with their agency.

Over the years, we have noticed that some adults find the notion of agency and play in art difficult, perhaps embarrassing. "The art should be doing the work, not me". It reminds us of one of our favourite sea creatures, the sea squirt. It has a telling life cycle. When young, it swims around exploring its world, moving towards nutrients and away from harm, learning and growing. Once it becomes an adult, it attaches itself permanently to a rock and its life enters a purely passive phase. From now on it filter feeds, tide in, tide out. It even digests its own brain, it doesn't need it any more. What a metaphor!

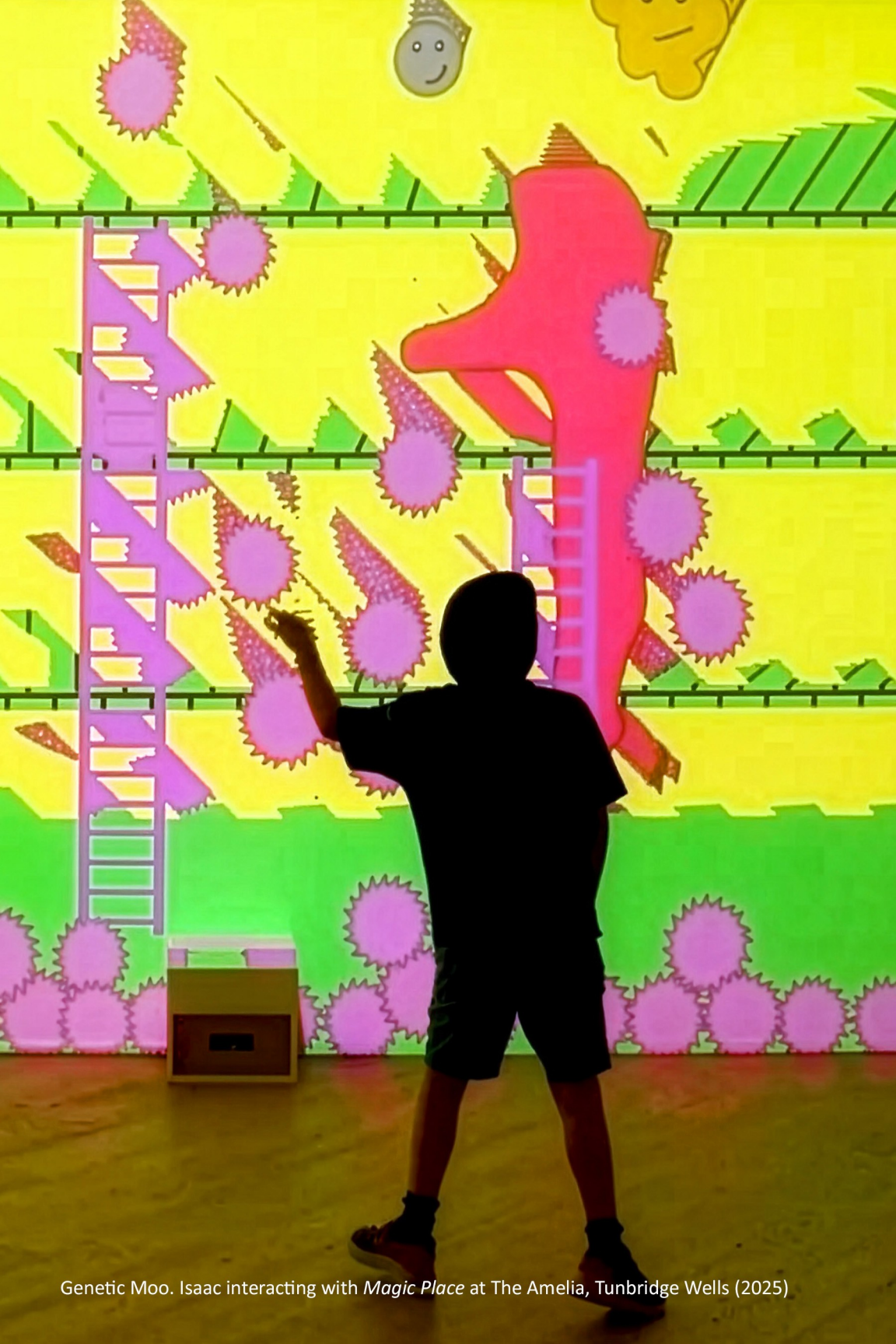
Play has been a part of modern art history with Dada, Duchamp and his Bicycle Wheel, Fluxus, Participatory Art, Happenings, Art Games, Web and Interactive Art but always somewhat on the periphery. Roy Ascott who made a series of *Activity Map* art games as part of his reinvention of the Art School in the 1960s, encouraged his students to "stop thinking about artworks as objects, and start thinking about them as triggers for experiences" and this has become our motto. But if art is a trigger for experiences then where does the art gallery fit in? The gallery model based on promoting and building art careers and then taking a certain percentage of the sales is being superseded. Take for example the ever-expanding empire of Japanese art collective TeamLab, mentioned earlier. They have sidestepped the traditional art world by building their own mega museums filled with playful art. These cater to a digital generation eager and willing to pay for immersive environments and large-scale participatory events. And these are the shows that are breaking records. Their audience has been playing video games all their lives, and this audience effortlessly brings their playful expectations into physical arenas where they can act together.

So what makes a good piece of interactive art?

After we have installed our shows we like to watch how the audience reacts to the space. This is particularly important when trying out new pieces. The *Microworld* format, where a lot is going on, is a great way to test new interactives alongside tried and tested ones. Each show is different with different combinations of pieces. We carefully watch how people respond to the new ones. We ask ourselves the following questions:

- Did the audience have a meaningful interaction?
- Did they understand what they were doing?
- Did it give them a sense of agency?
- Did they enjoy exploring the piece?
- Did they experience something new?

If the answer to these questions is "yes" then we have made a good piece of interactive art; and if they engage for a considerable length of time (several minutes to an hour) then we know we've made a great piece of interactive art. The user has been given agency to do as they want. In a world beyond our control, giving people back some agency is a good thing that art can do.



Genetic Moo. Isaac interacting with *Magic Place* at The Amelia, Tunbridge Wells (2025)

15. I am the Audience / Number One Fan

During the *Magic Place* show at The Amelia we heard of a super fan who, with his mother, had visited the show 14 times. David, the founder and boss of KitMapper, invited Isaac and Sarah as special guests to the next *Magic Place*, which took place at Somerset House's *Step Inside 25 Weekend* in 2025.

We asked Isaac a series of questions about his experience with our interactive art.

I saw Magic Place 14 times in The Amelia and a little one up in London, we went on a train. I met David up there and also the computer man who let me use his computer and change the animations on the big screen. People could see what I was doing, I liked that. I saw a new character called SMOO, I liked it. He was bouncing around like crazy!

I really like going to museums, I like to see skeletons of dinosaurs and beautiful paintings. I like to see sculptures too. I like seeing castles and fossils and plants and space. I like waterfalls and water features and things that turn around fast or slow. I like it when I can play with the screens.

Interacting makes me feel happy, I like feeling happy. My eyes like to react to my fingers touching things. It makes my heart feel warm. Magic Place made me feel excited and calm. I love it when the music makes me crazy and I run around and spin lots.

I like to interact on my own (or with my mummy). I don't mind other people being around me, just not too close. I liked Magic Place when it was busy too as all of the screens were moving at the same time and I could hear all of the different sounds and music. I like to show other people how to do it if they get confused or do it wrong!

I really liked it when the butterflies came and all of the blue balls, but not the cherubs, they jump scared me! I liked looking for all the different animals and designs that were on the leaflet, and would not go home until I found all of them. I also loved it when I could make the music change by catching the shapes. It was beautiful. Also the lightning coming out of my fingers was so cool. I liked those levels because they were so colourful and they were a little bit pixelated.

I do like video games, my favourite ones are Roblox and Geometry Dash. When I grow up I want to be an animator and make interactive art like Magic Place. I want David and the computer man to help me! I want nature sounds too and music not babyish music or definitely not Barbie! (Barbie is for girls and I'm a boy) I like ASMR. I don't want relaxing music but I like sounds that make me feel happy. I want to make a star constellation animation where I could touch the stars and move them to the right places. I want to make a video game with lots of levels. I have lots of ideas.

I would like there to be a rainbow room where you could add all the colours of the rainbow and 30 arrows. I want raindrops, sunshine and Super Mario Bros. Clouds. I'd like it to have 10 animals and giant sunflowers. I would like a dog, a cat, a bear, an alligator, a giraffe, a horsefly, a tiger, a rabbit thumping his foot, a snake, and a chameleon that could change colour when I touch it! An alphabet one with different fonts would be good too. I wish Magic Place would make a Geometry Dash cube that when I touch it, it would jump really high, but not too high!

Last words

So if you too are interested in getting this level of audience excitement, then use this book as a roadmap. There are thousands of museums and galleries across the UK, hundreds of which have temporary exhibition spaces, and dozens will be interested in your interactive art show. So get inspired – learn to program – do a course – join a group – organise a show – enter competitions – build your portfolio – find a producer – answer emails – be nice – spread the word – and keep going!

We leave you with another review of Magic Place, this time by an adult.

16. My Journey into Magic Place / Rebecca Bell

Having helped bring MAGIC PLACE to life, I thought I knew what to expect but being in the space was something else entirely. I stayed far longer than planned, caught up in its shifting colours and playful energy.

The whole space feels alive. As soon as you walk in, the walls begin to respond, colours shift, shapes ripple, and everything moves with you. It's like stepping into a video game, but softer, more thoughtful. I caught myself smiling at how joyful it all felt.

For me, it stirred something deeply familiar. I grew up playing games with my brothers and my mum huddled around old consoles and clunky PCs, laughing, competing, exploring. Gaming was how we spent time together, how we connected. MAGIC PLACE brought that feeling rushing back: the sense of discovery, of shared wonder, of being part of something that responds to you.

At one point, I sat down on the floor (something I don't usually do in galleries!) and just watched. A little girl ran past me, and the entire wall lit up in response. Her mum laughed, and we exchanged that kind of look you give a stranger when you're both caught in the same lovely moment. It reminded me how rare it is to feel connected to people you don't even know.

Nicola and Tim from Genetic Moo have created something that's not just fun, it's full of feeling. It's playful, yes, but also reflective. It made me think about how we interact with the world now, and with each other through screens, through movement, through shared experience.

If you're in Tunbridge Wells this summer, go see it. It's free, it's joyful, and it might just offer a moment of stillness or surprise you didn't know you needed.

Among shifting patterns and playful light, I felt the quiet joy of being together.

Genetic Moo. *Magic Place* at The Amelia, Tunbridge Wells (2025)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Acknowledgements

Thanks to David Upton for suggesting we write a book, and for all his support.

Thanks to the Computer Arts Society. We look forward to working on future projects together.

Thanks to all the contributors and the many people we've worked with along the way. See you on the next project.

Genetic Moo websites:
geneticmoo.com
microworld.art
magicplace.art

Author websites:
ernestedmonds.com
seanclark.org
kitmapper.com
juliaschauerman.com

CAS
computer-arts-society.com

Recommended Reading

1968. *Cybernetic Serendipity*. Jasia Reichardt (free on archive.org)

1970. *Expanded Cinema*. Gene Youngblood

1977. *Abstract Film & beyond*. Malcolm Le Grice

1984. *Vehicles, Experiments in Synthetic Psychology.* Valentino Braitenberg

1987. *The Armchair Universe: An Exploration of Computer Worlds*. A.K.Dewdney

1991. *Artificial Reality 2*. Myron Krueger

1992. *Artificial Life*. Steven Levy

1994. *Turtles, Termites & Traffic Jams*. Mitchel Resnick

1995. Out of Control. Kevin Kelly

1996. *The Web of Life: A New Scientific Understanding of Living Systems*. Fritjof Capra

2009. *A Philosophy of Computer Art*. Dominic McIver Lopes

2009. *Complexity: A Guided Tour*. Melanie Mitchell

2012. *Nature of Code*. Daniel Shiffman (free online at natureofcode.com)

2015. *Getting Started with p5.js*. Lauren McCarthy, Ben Fry, Casey Reas

2016. *Sonic Art: An Introduction to Electroacoustic Music Composition*. Adrian Moore

2019. *From Fingers to Digits*. Margaret A. Boden and Ernest A. Edmonds

These days, almost every artwork is described as *interactive*. The word has become meaningless. In this book, Genetic Moo explain what they mean by interactive art and why they believe it is the best way to create art with computers. They describe how they built up an 'acclaimed' art practice from a single interactive starfish to the large-scale museum exhibitions they put on today.

They could not have achieved this without working with others: researchers, creatives, curators, producers and technicians. Each role is reflected in a short essay by an expert in that field, culminating in the perspective of a 10-year-old boy who visited the Magic Place exhibition 14 times.