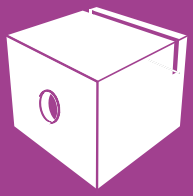

EARLY VISUAL MEDIA LAB

CICANT

Gert Wastyn is a multidisciplinary artist, professor, and researcher at LUCA School of Arts and KU Leuven in Belgium. Since 2003, he has worked in audio-visual art, illustration, and research, often exploring innovative intersections of art and technology. His completed PhD focused on the potential of Extended Reality in Expanded Animation and its impact on artistic practices. He has collaborated on projects including VJ sets, installations, and multimedia performances, continually pushing the boundaries of contemporary art and research. ORCID ID: https://orcid.org/0000-0001-7126-0748
gert.wastyn@luca-arts.be

Bart Geerts (Belgium, 1978) is an artist, researcher and educator who creates spaces in which looking, making, and thinking enter into dialogue with each other. He has a special interest in spatial (re)presentation models, the performative potential of visual work, the rhetoric of artistic research and drawing as a research method. Geerts holds MAs in Germanic Philology and Fine Arts and completed the postgraduate course at the HISK in Antwerp. In 2012 he obtained his practice-based PhD on the painterly, an exploration of the contemporary potential of painting. He currently is Assistant Professor at LUCA School of Arts and at the Higher Institute of Philosophy at KU Leuven (both in Belgium). ORCID ID: https://orcid.org/0000-0003-1873-9930
bart.geerts@kuleuven.be

Guido Devadder is an artistic researcher based in Leuven, Belgium, and a faculty member in the Department of Audiovisual Arts at LUCA School of Arts, Brussels. Currently pursuing a PhD in the Arts at KU Leuven / LUCA School of Arts, he explores and reimagines the idiosyncrasies of abandoned visual media and forgotten modes of creating and perceiving moving images. Merging old and new media, his research investigates the materiality of contemporary moving image art and offers a meta-critique on the elusive concepts of reality and illusion through expanded animation practices.
ORCID ID: https://orcid.org/0000-0001-8176-195X
guido.devadder@luca-arts.be

Steven Malliet is a game (design) researcher and musician. He is a founder of the Re:Anima international master in animation film. He has published internationally on game design, game history and analysis, media realism and enjoyment.
ORCID ID: https://orcid.org/0000-0003-2513-7970
steven.malliet@luca-arts.be

ARTISTIC EXPERIMENTS IN EXPANDED ANIMATION:

COMBINING 3D PRINTING WITH VIRTUAL REALITY TO CREATE ANAMORPHIC SHADOW ANIMATIONS

GERT WASTYN
LUCA School of Arts and KU Leuven

STEVEN MALLIET
LUCA School of Arts and University of Antwerp

GUIDO DEVADDER
LUCA School of Arts – KU Leuven

BART GEERTS
LUCA School of Arts and KU Leuven

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Abstract:

This paper explores the integration of virtual reality (VR), 3D printing, and anamorphic shadow techniques in the field of expanded animation. Using a collaborative and experimental artistic research method, the study contributes to extending the boundaries of animation, and to attributing a stronger sense of agency to the spectator or 'eccentric observer'. The paper discusses different iterations in the development of the 'Anamorphotrope', an original installation work that has been exhibited in two modalities: as a VR installation and as a 3D-printed zoetrope. Both on a technical and conceptual level the novel approach taken in this project has a number of implications for future practices in animation and related artistic fields.

Keywords: Virtual Reality, 3D Printing, Anamorphic Shadow, Expanded Animation, Interactive Art, Audience Participation, Immersive Technology.

Introduction:

In the past decades the medium of animation has evolved beyond the traditional format of the film screen, embracing new technologies and crossing over towards various art forms. This paper presents an artistic investigation into the performative and spatial characteristics of expanded animation, as this phenomenon is commonly referred to (e.g. Smith & Hamlyn, 2018). We will describe the iterative, experimental and collaborative development process of a hybrid (analogue-digital) animated installation work, titled the 'Anamorphotrope', which combines 3D printing, anamorphic shadow techniques, and VR to create a spatial experience. The convergence of 3D printing and anamorphic shadow animations within a VR environment represents a paradigm shift in how animated art can be conceptualised, produced, and experienced (Kavakli & Cremona, 2022). By addressing the creative possibilities of this approach, we examine how it can open up new pathways for storytelling, visual expression, and audience engagement. Furthermore, we will explore the conceptual implications for the future of animated art, with attention focused on its potential impact on the broader cultural landscape.

The paper will first elaborate on two artistic principles that have inspired and informed the creation of the 'Anamorphotrope': anamorphic art and expanded animation. In a third section we will describe the context of, and methodology applied in the 'Expanded Memories' research project, in the context of which this artwork was created. In the fourth and fifth sections the technological and conceptual foundations, respectively, of the Anamorphotrope are described in both its modalities: as a VR experience and as a spatial installation work. Finally we reflect upon the artistic implications of this research for the fields of visual art and film art, aiming to inspire and inform future practice.

1. Anamorphic Art

Anamorphic art is a visual art form within which a presented image reveals distorted or oblique perspectives, relative to the physical position taken by the spectator, and thus putting the spectator and the work in a spatial interaction with one another (Pagliano, 2024). An anamorphic work can usually be appreciated in its conventional proportions if the viewer assumes a precise point of view that unifies the image's perspective lines – but interesting artistic possibilities arise when the viewer moves away from this 'vantage point' so that additional visual layers are revealed (Pratt et al., 2023). This includes perspective manipulation and geometrical transformations to produce images that look misshapen or elongated when seen from certain points of view. While principles of anamorphosis are often employed to create optical illusions, its artistic use has been explored by surrealist artists (recognising its potential for creating a sense of alienation or decontextualisation) or installation artists (recognising its potential for intuitive spectator interaction). Historically, the technique can be traced back to examples as far as the Renaissance. Anamorphism has been used in painting, sculpture, and digital art and has been revisited, investigated and experimented with by several contemporary artists. An extensive overview of the history of anamorphosis and its contemporary workings can be found in Knoops (2017).

Artists like Istvan Orosz and Salvador Dali have applied anamorphosis to optical art, creating works that seem abstract or out of proportion unless they are reflected in a cylindrical mirror placed on top of or next to them (e.g. Collins, 1992; Turkmen, 2017). Noteworthy in the context of the current project is the use of anamorphosis to create a spatial experience around the projection of an animated video, for instance in the film What Will Come (has already come) by William Kentridge (2007) (Knoops, 2017). In this work, an original, distorted animated film, projected on a round rotating surface, is corrected by a cylindrical mirror placed in the middle of this surface, within which the spectator can experience it as a conventional sequence. The spectator becomes an active participant in observing either the distorted or the corrected image, or both simultaneously. The viewer of an anamorphic work is often referred to as an 'eccentric observer', who has to make an idiosyncratic effort to decipher and de/reconstruct the presented image (Collins, 1992; Knoops, 2017).

A specific form of anamorphic art is anamorphic shadow installation art, where the intended shape is revealed by a projected shadow, created by placing a light source at a specific angle or perspective (Pagliano, 2024). The observer, though not actively needed to create the image by assuming a suitable position, is invited to separate or juxtapose the physical installation (usually in a disproportional form) and the shadow projection (usually in a conventional form). The volatile yet clear shape of the shadow, in contrast with the distorted materiality of the object, creates a tension that is reflective of our perceptions of the world that surrounds us, specifically raising questions about realism and non-realism (Symeonidou, 2016).

2. Expanded Animation

Expanded animation is essentially an interdisciplinary art form, which challenges the conventional techniques and methods that have long been dominant in the animation medium (Smith and Hamlyn, 2018). Elements such as live-action, performance, installation art, VR, and interactive art can be, and have in the past decade increasingly been, expanded with animation. Though early examples of expanded animation can be traced back as far as the 1970s, both theoretically and artistically it has fully emerged since the turn of the century, for instance with increasing attention by leading academic organisations such as the Society for Animation Studies (SAS). Experimenting with new techniques to create multi-dimensional animated experiences has proven very fruitful in introducing animation into other art forms such as theatre, video art, and interactive art, and as such, enriching the vocabulary and toolkit of the animator. One interesting aspect in this evolution is the fact that, through these new approaches, spectators can be challenged to actively engage with an animated work (Harris et al., 2019). Using game-like elements, locative and tactile manipulation, sensor technologies and motion tracking, contemporary artistic practices allow several ways to integrate spectators as essential agents in a work, often even placing them at the centre of the messages that are conveyed.

There are some noteworthy artists within the domain of expanded animation. William Kentridge (Kentridge, 2007) uses different ways of projecting his animated films, linking anamorphic display techniques with nonconventional types of 'screens'. The performance animation dotdot dash (2018) by

Birgitta Hosea, used a tunnel wall as a canvas on which moving laser lines were projected, as activated by the voices of the spectators (Expanded Animation, 2019). The audio-visual installations of Mexican artist Rafael Lozano-Hemmer have explored the use of shadow animations on several occasions. For instance, his 'People on People' (2010) juxtaposes the spectators' physical presence to their disproportionately oversized shadows on a wall, which are in turn animated using scanning, texturing and pixilation techniques. Such experiments are not new, and can even be considered media archaeological attempts to reinvent the past in a contemporary context: we can for instance note striking similarities with Windsor McCay's 1914 experiments into the integration of animation and live-action performance (Crafton, 2018).

The artistic and research practice of the first author of this article has been closely intertwined with the emergence of expanded animation, and some of his works have contributed significantly to the inclusion of interactive elements in animation production.

The following is a first-person account by Gert Wastyn about practice in this field:

"In the early 2000s, I was crafting visuals for Video Jockey (VJ) sets at festivals, creating animated installations that allow spectators to explore micro-narrative moments at their own pace, and integrating audiovisual elements into theatre productions. Much of my work has ventured beyond the confinements of traditional animation. During my PhD research, I have embarked on a video mapping project that combined live performances with animated visuals" (Wastyn et al., 2021). Following such experimentations, it came as a natural choice to explore new dimensions of animation and how it interacts with audiences outside its usual settings, as a main topic for this article. The opportunities provided by the Expanded Memories research project, proved highly suitable to venture further down this artistic and experimental path, and in particular, to explore how processes of materialisation can contribute to the field of expanded animation.

3. Context and Artistic Research Methodology: The Expanded Memories Project

The 'Anamorphotrope' is a media-archaeological installation created in the context of the Expanded Memories research project, a collaboration between various artists and researchers as part of the EU-funded research infrastructure FilmEU-RIT. Artists and researchers from several institutions collaborate within the Expanded Memories project, including Universidade Lusófona (PT), Institute of Art Design and Technology (IADT) (IR), LUCA School of Arts (BE), and the Baltic Film, Media and Arts School (BFM) (EST). The project explores the tension between analogue and digital art from a variety of disciplinary perspectives, including philosophy, digital art, animation, game design, visual art and interaction design. The processes of materialisation and dematerialisation (using light and shadow mapping) are used to create artefacts that encourage reflection on the volatility of processes of cognition and memorisation.

The project uses an artistic research methodology (e.g. Coessens et al., 2009) centred around the iterative, experimental creation of artworks that are continuously adapted,

based on the dialogue between the different researchers involved, and observations made during exposition moments. The works created in the Expanded Memories project have for instance been exhibited at the Royal Academy of Art in Antwerp (April 2023), the INSHADOW festival in Lisbon (December 2023), and the exposium Non-fiction Animation and Memory in Brussels (December 2023). Essential to the applied methodology is the process of collaboration: several of the works entail a remediation or adaptation of earlier prototypes created (by other artists) in the Expanded Memories collective. In order to accomplish this we have set up an online open documentation infrastructure, where 3D models, print plans, video run throughs, and other assets, are shared with the other artists, who can integrate them in their own work. As such, the body of work developed in the project is continuously in flux, and each exhibition takes a different form depending on the current state of affairs of the project.

One common thread that unites all artworks in the Expanded Memories project is a tension between analogue and digital animation, which results in the creation of hybrid artefacts that have both a tactile and a digital dimension. For instance, the 'Anamorphotrope' exists simultaneously as a VR experience and as a (3D printed) cylindrical object that casts shadows when installed on a rotating surface with a strobe light positioned in the middle. In terms of collaboration and remediation, the 'Anamorphotrope' has been created in a creative dialogue with the media archaeological experiments conducted by Guido Devadder (also part of the collective) who reconsiders early animation devices like zoetropes and praxinoscopes using contemporary techniques. Taking as a starting point early versions of the shadow casting installations created by Guido Devadder, the Anamorphotrope represents a disproportionate, almost abstract, persona of which a walk cycle has been 3D printed and mounted on a cylindrical platform. Only when a light source is placed in the middle of this platform does the character's shadow convey the more conventional shape of a massive person who walks in a slightly hunched manner.

Fig.1 Noble, T., & Webster, S. (1998). 'Dirty White Trash (With Gulls)'. [Installation]. Retrieved from http://www.timnobleandsuewebster.com/dirty_white_trash_1998.html

On a conceptual level, our inquiry was informed by the question of whether light, capable of transmitting data, can be considered a form of memory preservation and, if so, whether darkness or shadow can represent its absence. It was theorised that cosmic background radiation might contain a type of gravitational wave memory, too small to be detected by the human eye (Cao et al., 2022), but with the potential of being visualised in the form of a shadow. In the preparation of the work we referenced, among other images, the shadows of the people of Hiroshima that were burned, or 'baked', into the stones, concrete and the sides of buildings after the impact of the atomic bomb (Serena, 2023), which gives an indication that shadows can literally materialise the memory of an event in a specific form or shape. Simultaneously informed by art installations where strategically placed objects, when illuminated correctly, cast figurative shadows on walls, we found particular inspiration in the 'Dirty White Trash (With Gulls)' installation by Tim Noble & Sue Webster (1998) that depicted a leaning, smoking and drinking couple, created from a heap of trash when lit from the right angle.

Our first explorations into light and shadow drew inspiration from childhood memories of shadow figures cast on bedroom walls, perceived as creatures or people. While Guido Devadder's first prototypes pursued a straightforward path, producing zoetropes that project shadows of walking figures, I investigated how the principles of anamorphosis could be approached from a technology-oriented angle using VR.

4. The Role of XR and VR Technology in Artistic Innovation

As VR and XR technologies are becoming more easily available, their uses are gradually becoming more widespread and influential. XR is used here as an overarching term, referring to technologies such as VR, augmented reality (AR), mixed reality (MR), virtual production (VP) and more. For the sake of clarity, we will predominantly address its main component, being VR, as it is most relevant to the paper (Marr, 2019). XR is currently no longer just a means of viewing content like videos and games, but can be considered a tool in its own right that helps audiovisual artists in their creative processes.

Several types of XR studios have emerged to facilitate the rise in VP during the COVID-19 period, and currently continue to be used (Willment, Swords, Thomas, et al., 2023). In addition to facilitating VP in several ways, these studios can help filmmakers and photographers create their craft in new ways that were unimaginable ten years ago. These studios are usually equipped with big high-resolution LED screens that envelop the stage and can display 3D environments aligned with the camera's vantage point. A virtual production studio is a technology-driven platform that uses real-time rendering, motion capture, and VR to create photorealistic 3D environments. It facilitates remote collaboration among teams and enables filmmakers to visualise scenes in real-time, experiment with camera angles and lighting setups, which grants more creative control (Willment et al., 2023). The possibilities of this technology move far beyond filmmaking. There are options to use it in several contexts, ranging from theatre and gaming, to workfloor training. While initially, VR had been mainly recognised for

its transformational capabilities within the gaming industry, it has recently been embraced by artists and designers in other audiovisual disciplines, such as animation.

Examples of such experiments range from VJing and music visualisation, e.g. VJ Visuals painted in VR (Lucin, 2019) and animation installations, e.g., Jon Weinel's 'Cyberdream' (2019) to embodied 3D environments, e.g., Lost Horizon Festival. Research shows many advantages to using VR and AR in creating animated films. Intuitive pre-visualisations and storyboards are made possible by spatial technologies (Ardal et al., 2019; Galvane et al., 2019). Employing VR controllers during production improves accuracy and spatial awareness (Cannav & Lamberti, 2018). According to Vogel, Lubos, and Steinicke (2018), controller-based animation is a technique that combines the advantages of classic keyframe-based animation and motion capture-based animation.

Animation professionals can now create complex 3D designs and animations in a virtual environment due to VR programs like Quill and 3D design tools like Gravity Sketch. By utilising spatial awareness, these applications offer a more intuitive approach to the design process and an immersive and organic experience that can boost creativity and productivity. One key benefit of these VR apps is that they do away with the need for complicated 2D interfaces, allowing users to engage with their creations utilising natural gestures and movements. However, its usefulness for exchanging experiences needs to be further investigated. Without direct user experience via a VR headset, it can be challenging to portray the different personalised experiences facilitated by VR.

My decision to incorporate VR into my toolkit stems from its capacity as a spatial creative tool. The VR production environment proved particularly suitable in the context of this project due to its adeptness at facilitating rapid prototyping and reconfiguring 3D shapes. This capability is augmented by the ability to cast artificial light upon these objects, allowing the forms of their shadows to be precisely previewed. While creating in VR is often viewed as an inherently solitary experience, I plan to explore strategies to overcome this limitation. By externalising the VR experience's outcomes, I aim to bridge the gap between individual immersion and collective engagement. The use of 3D printing technology was paramount in this process. This approach not only amplifies the utility of VR in creating anamorphic installations, but also broadens the scope of its application, making the results accessible and appreciable beyond the confines of the VR headset. The process of how I explored these applications, alongside their practical implications, will be further discussed in the next section.

5. Project Description and Development Process
The VR installation, or 'Anamorphotrope V1'

Critical to the 'Anamorphotrope' is that both object and shadow are visible simultaneously, causing a type of cognitive dissonance. Different methods of creating shadow anamorphosis were explored through digital prototyping, though always with the ambition to eventually translate the work into a physical installation. In order to create rapid and intuitive prototypes, we conducted a series of experiments using the Gravity Sketch software. The initial focus of these

experiments was to create an anamorphic shadow effect depicting children's imaginative perceptions.

The first prototype portrayed a wolf's anamorphic shadow. Noteworthy in this iteration is the abstract and whimsical shape of the three-dimensional object casting the shadow. An essential challenge we faced was animating the overall process to generate not just a single frame but a sequence of animated frames forming a loop. Gravity Sketch, the VR software used to create this piece, has been mainly known as a VR design program that does not contain any animation features. This issue forced me to adopt a more creative approach, for instance by looking at other non-animation programs that deal with similar issues. In software programs like Photoshop or Procreate animation is made possible by using layers as frames. I applied a similar technique in Gravity Sketch by creating a new layer for each frame – though this became somewhat complicated because the program offers no way to test frames or create a flipbook-style preview, a standard procedure in many animation programs to evaluate the smoothness of an animation.

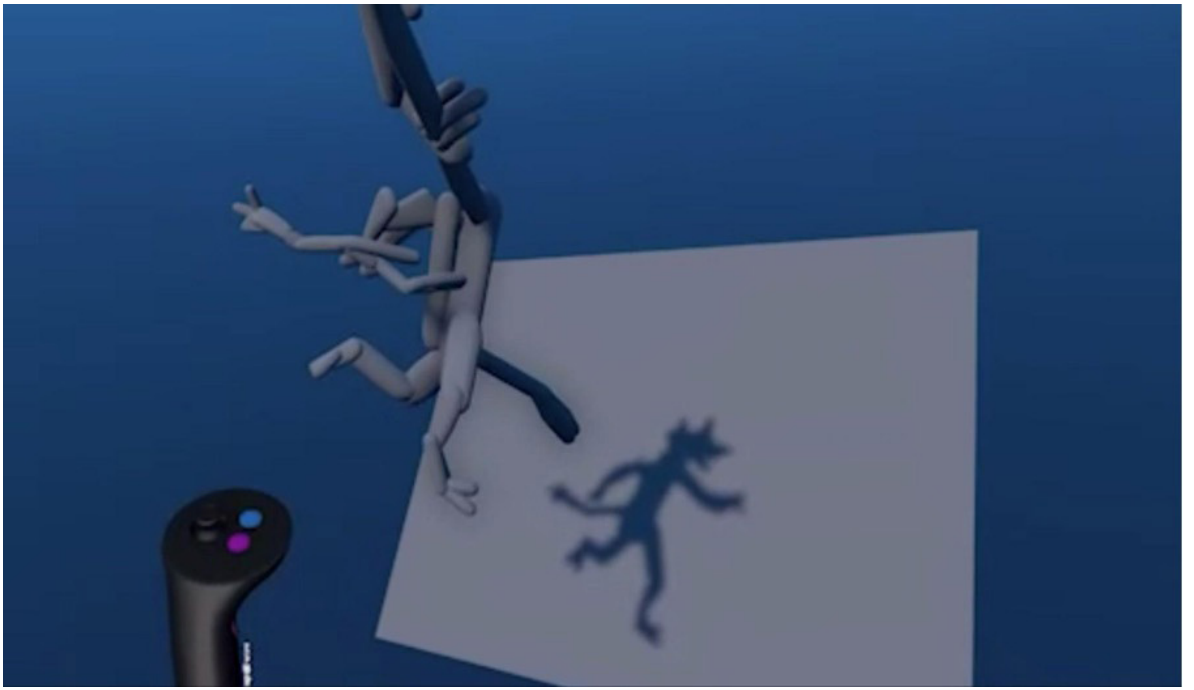

Fig.2 Wastyn, G. (2023). Wolf shadow experiment [VR digital art]

To work around this issue, I experimented with adjusting the transparency of layers, which allowed me to create an overlay of different frames. This helped me visualise the next frame and how the individual abstract 3D objects should be positioned. Since direct control over the animation, such as distinguishing breakdown frames and in-betweens, was not possible, I had to use a straight-ahead animation method. I worked with a start and end frame to create a loopable animation, but I lacked an effective animation system which could grant a clear overview on the previous and following animation frames. I found a solution by importing reference images within Gravity Sketch, which I used to mimic the correct walk cycle in my animation. Each element within the cycle was manipulated individually, akin to manipulating a puppet in stop-motion animation.

A fundamental difficulty in animating the walk cycle lay in simultaneously attending to the shadow shape while manipulating the distinct abstract forms responsible for the visual representation of the shadow's motion. In a way, I was animating two animation sequences at once, both to be viewed from a different angle. This ultimately led to an animated sequence that I would describe as a 'limping shadow monster'. At this point in the project I ran into a technical issue:

Fig.3 Wastyn, G. (2023). Anamorphotrope V1 [Video]. YouTube. https://youtu.be/zWRG5k-vycs

because the limping motion needed a slow portion where the leg was dragged back to its original position at the beginning of the loop, there was not enough room within the 13 available frames to shorten the animation without changing the loop's speed and the overall feel of the motion. Therefore, the decision was made to delete the frames with the returning foot, to accentuate the limp by having a quick frame-skipping motion instead of a slow dragging motion.

In the next step, each frame was rendered individually as an Object File (OBJ), which I imported into the animation software Blender to add lighting and compositing and to render a 360° video. Through placement of a camera centrally in the scene, the viewers could find themselves in the middle of the 3D zoetrope as the film played, creating a first, virtual experience of the work.

This walk cycle was exhibited and evaluated as a VR installation. To refine the user experience of the installation, we tested a 360° render of the video within an immersive projection room. Although initial testing took place at Aalto University in Espoo, Finland, utilising their Igloo 360° projection room, in collaboration with researcher Tanja Bastamow, our ambition was to produce the anamorphic shadow as a 3D-printed zoetrope installation, moving from virtual production to the creation of a tangible artefact.

The 3D-printed installation or 'Anamorphotrope V2'

The tests conducted during this first iteration revealed that there were some issues with the projector alignment, which could not be easily fixed in a room of this type. At the same time I obtained insights on how to translate this work into a 360° video installation – specifically which parameters I would need to adjust to make its analogue component more impactful. In order to create an optimised 360° projection room suitable for this project, expensive technology would be needed, and therefore the decision was made to shift our focus towards the creation (using 3D printing) of physical instances of the work that could be exhibited as tactile objects.

Fig. 4. gives an example of the first printed frame using a Formlabs 3D resin printer. This frame was printed because it was essential to test if the cast shadow produced by the rudimentary lighting system of Gravity Sketch could be recreated in an analogue, material context. Regardless of its delicate shape, the 3D print looked very similar to its virtual counterpart and none of the detailing was damaged while cleaning the 3D-printed shape. Removing the 3D-printed supports included the risk of breaking the more vulnerable details of the 3D-printed form.

Seeing that the installation would use LED lights similar to those used in smartphones, we tested the shadow casting using a smartphone light. The shadow looked almost exactly the same as its digital counterpart. The frame size of the printed test frame was too big to be used full-scale, so the actual prints had to be scaled down somehow.

While implementing a 3D-printed animated walk cycle, we opted for the zoetrope principle, inspired by earlier work of Guido Devadder. All frames were rescaled to a smaller size and printed using the Formlabs resin printer. However, it

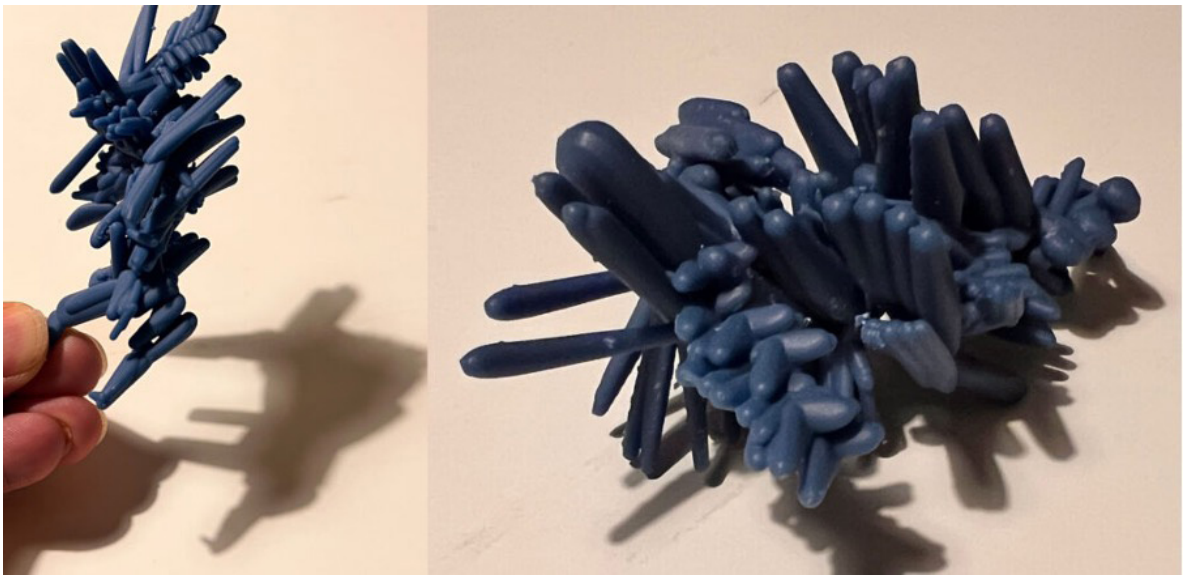

Fig. 4 Wastyn, G. (2023). 'Anamorphotrope V2' test print [3D print]

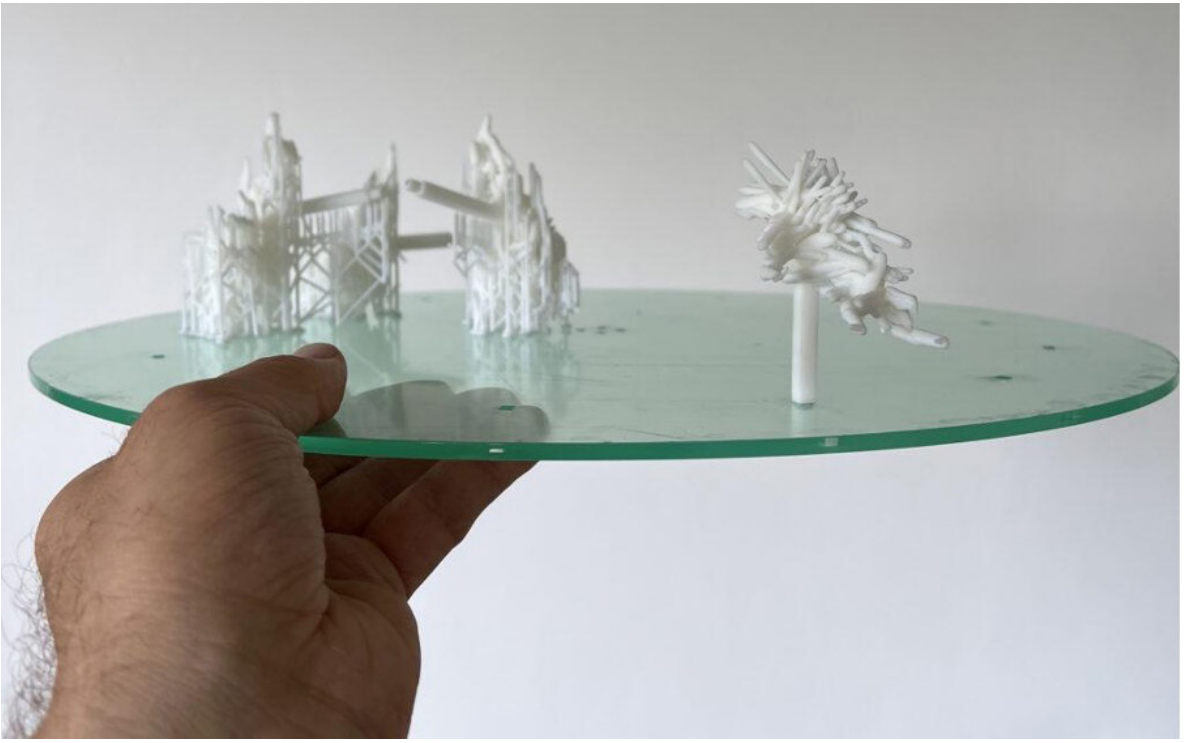

Fig. 5 Wastyn, G. (2023). 'Anamorphotrope V2' test print part 2 [3D print & Installation]

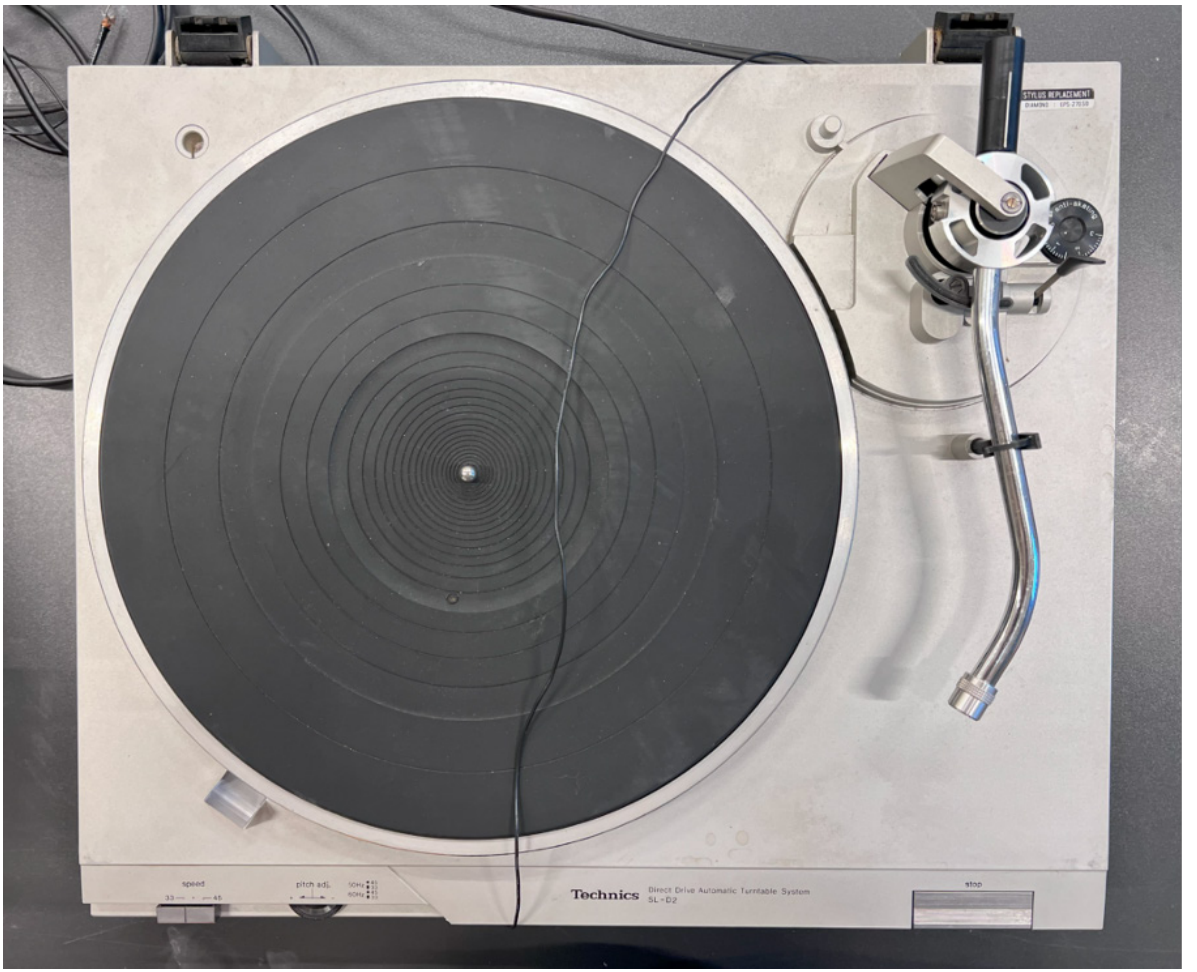

Fig. 6 Wastyn, G. (2023). Repurposed record player [Photograph] I designed a box for it in Makercase that I slightly altered using Adobe Illustrator software. This box was laser-cut to house the repurposed turntable record player.

became apparent that by sizing down the frames, the printed supports were impossible to remove without damaging the more delicate parts of the prints.

The parts needed to be printed again, using an Selective Laser Sintering (SLS) 3D printer this time, which solidifies powder resin and does not need printing supports, and as such gives a better guarantee that the frames will not become

Fig. 7 Wastyn, G. (2024). 'Anamorphotrope V2' [Installation]

damaged during cleaning. For the rotating mechanism I used an old turntable that I could repurpose.

All frames needed to be housed on a transparent disc from which the shadows could be projected onto a surface below. Using Adobe Illustrator software, I designed a disc that could be laser-cut out of plexiglass. It was designed with slots that could lock each frame in place, through addition of a support element that could hold each frame in its exact position. I also needed a centre cylinder to support the zoetrope platter and the shadow projection plate to project the animated shadows. The cylinder was created using a cardboard pipe that I reinforced on each side by glueing in wooden caps. The shadow projection plate was also cut from a wooden board using the laser cutter.

After assembling and painting the installation, the animation was tested using a mobile phone LED and an app called 'Stroboscope' that can adjust the video shutter speed of whatever footage it is recording. This proved a suitable way of finding the right speed pitch, which could be adjusted by using a rotary controller that was present on the record player. After finding the correct parameters, the installation was exhibited at

Fig. 8 Wastyn, G. (2023). Anamorphotrope V2 test footage [Video]. YouTube. https://youtu.be/kNDiKCWOJeM

the Exposium Non-fiction Animation and Memory in Brussels, 8 December 2023.

6. Reflections

It is difficult to capture the essence of this project in a paper because it can only be fully appreciated by standing inside the activated installation in a dimly-lit room. Usually, audio-visual installations are meant to be experienced firsthand, and in some instances, require the participation or inaction of the observer, similar to the engagement required for some of the earliest anamorphic artworks where the observer played a more active role. To film the operation of the Anamorphotrope, a special app is needed that allows the shutter speed to be adjusted to match the frequency of the installation's frame rate. Aside from this technical detail, the role of the participative spectator or 'eccentric observer' (Collins, 1992) remains central to the full experience of this work. During a presentation of the project, it was suggested that the analogue experience of this work cannot be truly replicated by recording it. When viewing a recording of this work, there is no way to adjust the viewing angle to explore the disconnection between the two separate animation loops from another perspective. Moreover, the experience of the animation is not the same; the true effect remains unreproducible. Through video archiving, we can gain but a sense of what the experience is like.

Trying to use a device or installation like the one described in this paper is fitting, but also falls short in the same way other means of archiving the past fall short. Memories can be revisited, yet they inevitably fade and can never be relived with the immediacy of their original moment. Although recordings might trigger emotions or nostalgia for these memories, the experience was only real in the moment in that time and space where one lived it. The 'Anamorphotrope' was based on this principle (taking a childhood memory as its starting point) but it cannot fully revive that memory. Its effect and the experience underscores the irreplaceable nature of the analogue encounter with the artwork.

The installation itself, displayed at an exhibition, remains a first prototype. Ideally, in a third iteration, the zoetrope animation would incorporate a secondary layer of animation, wherein the various objects comprising the anamorphic shadow animation would possess individual secondary animations. These animations would involve moving separate items, such as tables, lamps, and chairs. While synchronised with the overarching primary animation, these secondary animations would provide an additional layer of visual dynamics. This further iteration would allow for more narrative elements to be added, underlining or clarifying the memory that is evoked with the installation.

7. Conclusion

This study, which explored the boundaries of expanded animation by using VR as a creative tool, established a step in investigating the fusion between 3D printing and anamorphic shadow animation techniques within a VR environment. Both technically and conceptually, our results can help reconfigure the contours of animation through the application of a hybrid materiality and a collaborative artistic research method. Primarily an experiment in creating unusual visual narrative forms, the investigation additionally provides a pathway to

include a stronger sense of audience interactivity, inviting viewers to position themselves and engage with the work from their own unique perspective. This kind of spatial interaction allowing spectators to position themselves within the animation is a direct consequence of tracing the roots of anamorphic art and of searching for new forms of artistic expression in the contemporary technological landscape.

This interdisciplinary approach adopted in the Expanded Memories project showcases the potential of crossing traditional barriers of animation, and of exploring the creation of multi-dimensional, interactive and visually engaging audio-visual works. The findings of this research indicate how, as shown in the presented case, innovation continues to play a vital role in the history of animation, and specifically, how the animated medium can take hybrid forms, be it in combination with live-action, performance art or interactive art. Although animation film is continuously innovating with respect to pipeline production techniques – cfr. for instance, the innovation track record at Disney studios (Vary, 2023) – this innovation should have an equal place within the non-conventional forms of animation, such as expanded animation.

By extending the animation medium through a continuous questioning of its own boundaries and making them permeable, animation is currently undergoing an evolution that other art forms have gone through in the past. This project highlighted the experimental, multidisciplinary nature of expanded animation, which can result in the creation of an artistic concept that has not been attempted before: animated, 3D-printed anamorphic shadow installations. Though partly unintended, as part of a research trajectory, this concept can be further fine-tuned, deepened and extended in future iterations and forms.

The research also shows that the use of VR as a spatial creative tool does not necessarily result in a digital artwork. Even though the animation frames were created with a VR tool, the digital nature of VR can also be considered a gestation form, an in-between phase, on the way to an analogue or hybrid final form. Embedded in the Expanded Memories project, the 'Anamorphotrope' explores the synthesis of analogue and digital techniques, aiming not only to blend these two seemingly disparate worlds but to show their inherent interconnectedness. The use of VR technology is not a goal in itself, but an integral part of the toolkit of expanded animation.

As the artistic world has entered a new state of flux, of which spatial computing and artificial intelligence models are a prominent part, it is obvious that animation does not remain immune to these new models and technological advancements. This study has shown the advantages of allowing these new technologies into the domain of expanded animation without losing track of the analogue techniques that the medium of animation is rooted in.

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