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Pablo Gobira (https://orcid.org/0000-0002-3054-2383), UEMG/UFMG
Professor at Escola Guignard/UEMG, PPGArtes/UEMG, PPGACPS/UFMG, and PPGGOC/UFMG. He is also the Director of the research, development, and innovation group Laboratório de Poéticas Fronteiriças and President of the organising committee of the International Congress of Art, Science, and Technology and the Digital Arts Seminar (CIACT-SAD).

Emanuelle de Oliveira Silva (https://orcid.org/0000-0003-3052-887X), UFMG
PhD candidate at PACPS/UFMG for the Built Environment and Sustainable Heritage Program. She has a Master's in Arts from PPGArtes/UEMG and was an undergraduate in Fine Arts at Guignard School/UEMG. She is a FAPEMIG fellow with a PhD scholarship and a member of the research, development and innovation group Laboratório de Poéticas Fronteiriças (UEMG/CNPq).

Eduardo Séllos (https://orcid.org/0000-0003-1605-1884), UEMG
Master's student at PPGArtes/ UEMG. He holds a Bachelor's degree in Cinema and Audiovisual Studies from UNA University. Member of the research, development and innovation group Laboratório de Poéticas Fronteiriças (UEMG/CNPq).

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DIGITAL ARTS, DIGITAL GAMES AND VOLUMETRY:

STATE-OF-THE-ART AND CURRENT SCENARIO

PABLO GOBIRA

EMANUELLE DE OLIVEIRA SILVA

EDUARDO SÉLLOS

Abstract

The paper presented here stems from the experiences had at Laboratório de Poéticas Fronteiriças, LabFront, a research, development and innovation group that aims to problematize at the borders of the fields of science, art, and technology. One of the most relevant aspects of social construction currently is the way new, state-of-the-art technology is being applied to visual and artistic creations, and how it helps us shape and understand the reality we live in. Specifically in the third decade of the 21st century, the applied potential of digital games, or gamified applications, is virtually present in most aspects of our day-to-day lives. In this paper, we propose to analyse better how such creations, which we understand as a facet of digital arts, are relevant to the ever-developing world. Having a special interest towards the use and application of new technology and how it affects the strength of such visual, poetic constructions this paper aims to analyse how and in which ways new volumetry technologies are (or can be) used in digital game as a way to strengthen and expand the possibilities that such creations can achieve and, consequently, its social impact and reverberation.

Keywords: Digital games, volumetry, volumetric videos, digital arts, 3D games.

Introduction

The paper presented here is based on the work done at Laboratório de Poéticas Fronteiriças (LabFront - http://linktr.ee/labfront). LabFront is a a research, development and innovation group and it aims to discuss and investigate the relationships, productions, and discourses that happen on the frontiers of the fields of art, science, and technology. Primarily generating propositions from an artistic perspective, we recognise the need and relevance of such interfaces in all areas of human life and culture. That is because the poetic dimension of creative thoughts and discussions enables other fields to expand and develop in ways that would not otherwise be investigated. A clear example, and the overall aim of this paper, is related to volumetric videos. As will be clear later in this paper, technologies for such applications have been developed throughout history, in a diffuse and non-directly purposeful manner, with adaptations made in different fields to enable their use. However, its use is still, overall, limited to a few scientific areas, despite the multitude of other possibilities it can add to various fields of research and production.

Our unique perspective, as a group that aims to problematize the borders of art, science, and technology, enables us to understand better and analyse the possibilities brought forward by different scientific and technological advancements through a poetic lens that is unique to the field of the arts. That is, while other areas have a more practical focus, analysing, investigating, and developing ideas brought forward by applicable needs, a poetic view of such creations enables the user to expand, explore, and discover possibilities that surpass the previously defined barriers that exist in these "hard" fields. As it is, we have a historical record of artists pioneering the use of different technologies in their work, launching not only new creative possibilities in the artistic field but also expanding the ones from which those systems and/or objects originally stem. For example, the development of computerised systems had been in the works since at least the beginning of the 20th century, being utilised for relevant encryption work in the Second World War. However, such technologies were kept in specific military/industrial areas, requiring a high level of previous technological knowledge to enable their utilisation and application. It was in the 1950s that artists, such as Harold Cohen and Ben Laposky (amongst others), produced the first iterations of what would become known as Computer Art, one of the first important facets of the digital arts. These artists started the imaginary use in computerised systems through their artistic experiments, something that was, up until the middle of the 20th century, not primarily thought of or investigated, seeing that its use focused solely on the processing of binary information, with the use of 1s and 0s, since that was what the technological fields and their experts needed. The term' Computer Art' needs to be defined here, so as to enable the beginning of the discussions that will take place in this paper, as it is the driving force behind them.

> In regards to the term digital art, it is relevant to understand it as art-science-technology, as a production that encompasses computability, interactivity, immersion, real time behaviours in artworks-projects-works that connect other fields of knowledge, in researches evolving biotechnology, nanotechnology, physics, computation, mathematics, engineering,

> mechanics, robotics, amongst other areas, interfaced by digital medias (Gasparetto, 2016, p. 15. Translated by the authors)

We can thus understand, based on the quote above, that digital arts is a term best used to describe the multitude of possibilities created artistically by the convergence of different areas. As shown, albeit briefly, with the citation of Computer Art, similar digital technological developments were adapted into artistic discourse throughout the years. Such a merger not only powered the insurgence of new artistic movements, but also, in a feedback system, displayed to researchers in technological and scientific areas possibilities of use and discussion enabled through the developments in their specific areas. In other words, the use of digital technologies/developments by artists in their work showcased new investigations and possibilities that their original fields, without a poetic approach to their creations, could not perceive. Therefore, such digital artistic productions pushed for investigations that expanded technological and scientific fields to comprehend different, innovative uses.

When discussing volumetry, specifically the volumetric video aspect that we will focus on further in this paper, it is essential to highlight the interactive condition intrinsic to its existence. The primary difference between a standard video and a volumetric video lies in the viewer/user's capability to move through a three-dimensional rendered space or object. There are many possibilities for creating an interactive digital artwork, so it is necessary for us to limit the scope of options and research we will present here to establish some sort of specificity. Being as such, we have chosen to discuss here its application in regards to digital games, understanding them as a facet of digital art that, through the use of multiple different developments, has slowly but surely, forever changed our social and cultural landscape. That is, having the understanding that digital games are recognised, both by the industry as well as in academia, as a poetic, artistic production created through/by digital means, with the necessity of the added dimension of digital technology in its construction, its existence on its own interpolates with the definition we've shown here to be the consensus in literature of digital arts. In general terms, we understand the importance and impact of games, as a whole, to the development of human culture. Johan Huizinga, a Dutch researcher, in his book *Homo Ludens*, delves deeply into the existence and reverberation of games, providing us with the knowledge that playing precedes culture as we understand it.

> In tackling the problem of play as a function of culture proper and not as it appears in the life of the animal or the child, we begin where biology and psychology leave off. In culture, we find play as a given magnitude existing before culture itself existed, accompanying it and pervading it from the earliest beginnings right up to the phase of civilization we are now living in (Huizinga, 1980, p. 4).

Huizinga published the book in 1938, decades before Steve Russell, an American engineer, developed the game *Spacewar!* at the Massachusetts Institute of Technology (MIT) in 1961 – a game that would come to be widely recognised as one of the first ever digital game productions. The research and analysis done by Huizinga in his book had no intentions

or need to try and imagine the future, as the role of the game was already settled: as humans, we learn and create as we play, especially amongst others, as the playing doesn't require a human conscious process to exist. Even animals play. However, the impact of games on human development cannot be seen as clearly as it is now, given the ubiquity of digital games interconnected through the internet. Not only is the direct impact of games relevant when analysing human culture, but also the indirect impact, given that game dynamics are heavily applied in social, political, economic, and military contexts to help train, develop, and accustom people in accordance with their specific needs (Gobira, Silva & Oliveira, 2024). We must approach matters regarding digital games, seeing that, with the idea of analysing and discussing poetic possibilities of volumetry in this paper, one of the most relevant "non-industrial" uses – that is, of access to the general population, without an inherent need for specialised knowledge to enable its use, and applicable/to areas of daily use.

Based on the points made thus far, we can correlate the necessity of convergence of the areas of art, science, and technology to the current rapid development and expansion of digital games, enabling us to approach volumetry from an intended prism of transdisciplinarity, understanding how it is contextually possible for it to be applied to the area of digital games. Thus, the goal of this paper is to investigate the existing and potential relationships between art and digital games in their direct and indirect cultural and social impacts on human life. Here, specifically, we aim to analyse the current application of volumetric videos in digital games, as it can be considered one of the newest state-of-the-art digital technological developments in the field. Through such analysis, we will also be able to grasp better how and to what goals it can be applied in our current historical, social, and cultural scenario.

To achieve our goal, we have divided this paper into two sections, in addition to this brief introduction and our final considerations. In the first section, we will explore what volumetry is and related technologies, providing the necessary background to understand its use in digital arts and games. Through this more direct, historically contextual approach, the reader will have the required information to understand, in the second section, the intrinsic and deep-rooted relationships between art and game, and how the convergence of multiple fields is necessary to enable the complexity of the results and products that have been, and continue to be, created.

Volumetry, Volumetric Video, Digital Arts and Games

As is the main goal of this paper, and the overall aim of LabFront, in an attempt to contribute and better understand the state-of-the-art discussions currently being developed (here specifically in the areas of digital arts and games), we will approach the use of volumetry in game/game art. To do that, however, we must first explain what volumetry and volumetric video are, as well as their historical context. Due to space constraints and to avoid making this paper overly complex, we will not cover every single technological development that has enabled us to arrive at volumetric technology ultimately. Technology is often developed concomitantly by different actors around the globe, and it is almost impossible in most

cases to define a straight line of chronological development; thus, we have made our best to enable a coherent developmental progress that touches upon the most relevant cases when considering this paper's goals.

As a technology that originally belongs to the fields of computer science, volumetric video, also referred to by researchers as videometry, is a form of computer visualisation technique. Although we cannot pinpoint exactly the first experiences of utilising computerised systems to gain a better understanding of a dataset, it is known that, as early as the 1960s, experiments were conducted with simulations of numeric values that required a graphical representation (Gallagher, 1995, p. ix). Thus began the research aimed at improving the simulation and transformation of numerical information into visualisation models. That is because "Visualization provides an interface between two powerful information processing systems — the human mind and the modern computer", as we are able to understand "Visualization [a]s the process of transforming data, information, and knowledge into visual form making use of humans' natural visual capabilities. With effective visual interfaces we can interact with large volumes of data rapidly and effectively to discover hidden characteristics, patterns, and trends" (Gershon, Eick & Kard, 1998, p. 9). Thus, the process of visualisation opened new possibilities, not only to fields related to computer science, but to others as well, as it made it easier to access and work with computerised systems without a specific need of programming or engineering background to understand the complexity of their codes. In other words, visualisation in computer systems can be understood to serve as an artistic interface, enabling the participant in a system (the user) to be integrated into it.

Having its origins still in the middle of the 20th century, we can identify photogrammetry technologies as one of the first and most recognisable investments in the computer visualisation field. Although not specifically the focus of this paper, we need to address this development as it is tangential and enables a better understanding of volumetry. The term **photogrammetry** has existed since the late 19th century and has been enhanced/adapted with the added possibilities of computational technologies, thus becoming digital photogrammetry. It pertains to the "measurement technique that is used to extract the geometry, displacement, and deformation of a structure using photographs or digital images" (Baqersad *et al*., 2017, p. 18). Based on that knowledge, and understanding that the development of videometry follows that of photogrammetry, we can correlate their specificities to acquire the acknowledgement of **videometric techniques** as the processing of datasets into a volume-ready computer simulation.

In other words, "Volume visualization is a method of extracting information from volumetric datasets through interactive graphics and imaging, and is concerned with the representation, manipulation, and rendering of these datasets. Volume data are 3D entities that may have information inside them, may not consist of surfaces and edges, or may be too voluminous to be represented geometrically. Volume visualization encompasses an array of techniques for peering inside the dataset and for interactively extracting meaningful information from it using transformations, cuts, segmentation, translucency, measurements, and the like" (Kaufman, 1996, p. 165). Concurrently, **volumetric videos** can be understood as the use of volumetric captures for/of video formats. More

specifically, "Volumetric videos are truly 3D, allowing six degrees of freedom (6DoF) movement for their viewers during playback. Such flexibility enables numerous applications in entertainment, healthcare, education, etc" (Han; Liu; Qian, 2020, p. 1).

As pointed out in the previous citation, such digital technological developments have a vast array of applicational possibilities. A specific highlight for us in this paper is the entertainment value and its role as an artistic interface to enhance user experience in digital games and/or game art. Most of the research on volumetric videos, a new facet of volumetry application/development, has been conducted in the 2020s. That is because it requires extensive use of digital technology, energy, data space, and equipment, which, until recently, were not available to the general public, being confined to military and industrial use due to their extremely high costs. The price of the different requirements for the creation and application of volumetric videos have decreased significantly in the past decade, making it so that "Volumetric video services and their underlying technologies have [now] a huge potential in revolutionizing multimedia applications for the future", however, considering it is still a newly trailed path, "As an emerging field, the terminology used in volumetric video studies is inconsistent" (Jin *et al.*, 2024, p. 3). The multitude of applications and equipment currently available with which is possible to capture and create volumetric videos also make it so that the researches on the matter are still varied with not many common denominators and/or agreements between researchers, with "volumetric video technology [...] still in its infancy, holding immense potential for growth and innovation" (Jin *et al.*, 2024, p. 1). It is, thus, impossible for us in this paper to approach all of the experimentations and applications of volumetric videos in current development. However, we need to present a few practical cases to provide a better understanding of its potential, especially in the context of digital games.

For example, with the use of head-mounted displays (HMDs), volumetric video captures can be created and reproduced, breaking new ground as a powerful tool in technologically aided reality systems. "With the ARKit by Apple and ARCore for Android, mobile devices are capable of registering their environment and put CGI objects at fixed positions in viewing space" (Schreer *et al.*, 2019, p. 4310). Especially for entertainment purposes, it opens a door for deeper user immersion than what we currently experience. When approached through the lens of gaming, there is still a lack of experimentation with user immersion. Haptics have been adapted to enable gamers to feel the tremors and movements of their characters on the screen; however, self-insertion is somewhat limited, as it still maintains a distance between the player's body and the on-screen environment. Technologies such as Xbox's Kinect use sensors to allow users to move and/or interact with the game on screen using their entire body. When considering such developments and possibilities with the aided dimension created by volumetric videos, games can be developed to be environment-transformative. In other words, with the use of haptics and volumetric video-enabled captures and game dynamic construction, the users can be directly inserted into the games' environment in a more seamless, dynamic, and true-to-form manner, with not only the sensations but the visual and sound cues and constructions being recorded and interactive rather than simply emulated or modelled. These

technological developments are specifically relevant to the interactive narrative dimension that exists in games.

The concept of narratives is important to games, especially regarding the type of digital games we approach in this paper. Although, as we have seen in Huizinga (1980), playing precedes even human culture, the construction of games implies a need for pre-existent rules and goals to be achieved. Such necessities ultimately create a narrative, a gamified one. That is, there is a story, a beginning, a middle, and, at times, an end, including one or more participants. Narratives exist in various forms and media; however, "the intrinsic properties of the medium shape the form of narrative and affect the narrative experience" (Ryan, 2004, p. 1). Thus, when discussing the games, we need to take into account the specificities that create and shape the narrative within the environments they develop. It is, ultimately, an interactive-centred narrative that exists in games. That is because the game only exists as it is played, as different agents interact with, follow the rules, and play according to the directions, reaching (or not) the proposed goals. This concept is similar to interactive arts, and consequently, we can understand interactive narratives as the central point of the poetic construction in game arts. It is the discussions proposed by the artist and their team, created through the interactive process, that make the artwork exist and enable its poetics. And, although there are digital games that can be understood as narratively simple – such as digital card games, landmine, amongst others –, when we enter the realm of games that present the user with a character, with an larger interactive setting, environment, digital objects, that show a clear put, extensive and developed in-game history, amongst others, the importance of the interactive narrative grows, as its rules pre-exist the entering of the user(s) in the game. The story can only unfold, regardless of the paths it takes, as it is constructed by the user(s).

Some games and game arts in specific delve even further into such contextual possibilities by, with the use of the internet, creating a hyperconnected world that is accessible by different people throughout the globe at the same time, with one's actions impacting not only the game's environment but also other players and their characters. Those are called open-world games, and have a vast number of subgenres that would be too extensive to quote here, but that we can understand as interactive dramas. That is, not only is the supposed goal of the game the players' objective, but the construction of the story, the interactions, the gaining of knowledge, and the expansion of lore are just as important parts. Such is the extent of the narrative dimension's importance in these games that many don't have a clear end in sight, with players able to continue creating, building, and developing their character and/or environment for as long as they wish. Other game genres, not being open-world, also rely heavily on interactive narrative and can be considered interactive dramas.

Battle Royale, Multiplayer Online Battle Arena (MOBA), Hero Shooter, First-Person Shooter (FPS), Role-Playing Games (RPG), Massively Multiplayer Online Role-Playing Games (MMORPGs), Action-Adventure, amongst many others, can be (and often are) interactive dramas, according to the intention of the developers. Not only the potency of the games themselves, but also the in-world and general world cultural developments – thanks to the multiplayer and interactive possibilities, for example –, but we have been witness to the

emergence of a specific type of gamer: the streamer gamer. Gathering a hoard of followers across multiple platforms, these individuals, commonly known as influencers, livestream games they play, whether narrative-heavy or not, to an open number of viewers. Those viewers, who may or may not be able to enter the game and interact with the environment or the influencer, are still connected and part of the narrative being developed as they follow the storybuilding that is being created – now in an almost *mise-en-abyme* way. Directly or indirectly, they are part of the reverberations produced by the game's narratives, thus expanding its possible initial intent n-fold.

Having delved into the importance of interactivity and narrative to games, let's now return to the before-mentioned volumetric video and its possibilities for this type of media. When entering different research papers, book chapters, and similar works, we are almost always informed of the immense potential of reality-changing volumetric video applications. Regarded as one of the current state-of-the-art technological digital developments, volumetric videos are often praised for their enhancement possibilities when compared to traditional videographic methods. "VVs are different from traditional video media in two distinctive ways. Firstly, VVs are 3D and typically represented as 3D point clouds or 3D meshes (polygons). Secondly, VV offers 3D rendering capabilities with six degrees of freedom (6DoF), making them interactive, immersive, and expressive from a viewer-controlled first-person perspective. VV facilitates 6DoF by allowing audiences to freely change their viewing position (X, Y, Z) and orientation (pitch, yaw, roll). By contrast, conventional and modern 360° videos are presented on a two-dimensional (2D) plane, or a three-degree-of-freedom (3DoF) sphere. Thus, classic 2D videos provide no viewport freedom, and 360° videos only allow 3DoF (pitch, yaw, roll), with the viewer's normal, transverse, and longitudinal positions are permanently fixed or 'baked in'" (Young; O'Dwyer; Smolic, 2021, p. 591). The freedom of movement and visualisation enabled by volumetric video possibilities enhances the viewer's experience by allowing a better contextualization and understanding as they are placed "inside" the scene. It is a step further from what was attempted to convey in 3D videographical productions, as it both brings out the objects in the scene and immerses the viewer into the setting.

With that knowledge in mind, projects have recently been developed that focus on the narrative possibilities of volumetric video applications in the entertainment industry. It is essential to note that, although the creators and artists may use different terms for their work, our analysis considers practical matters from both an artistic and a game studies perspective. Therefore, this enables us to approach different productions by considering their specificities of construction and presentation, rather than focusing solely on terms. When utilised in entertainment, volumetric video, much like other digital applications, has a great potential to be understood as a game, due to its dynamic and interactive nature.

As we have pointed out before, the narrative is also a key element in games and game art, as it is in theatre, for example. The borders between game and play (in the Shakespearean sense) can quickly be blurred (and those made irrelevant) when added to the quality of interaction. The mise-en-scene created by directors, actors, cameras and the likes thereof, in

the case of volumetric video, transports also the viewer (now agentplayer) to the environment making their decisions directly and indirectly relevant to how they will understand and perceive the scenes and actions – differently than traditional videos and/or plays where the audience has to see the actions played from one single point regardless of who they are. Such a gamified creation, when analysed poetically, can be understood as a form of game art.

We can then understand projects like the *MR play* (2017-2020) trilogy as a work of art in the game medium. Developed by the V-SENSE project1, the work is presented as:

> In the theater, the audience passively observes the interaction between the light operator and the actors. The objective of the series of research experiments was to incrementally increase the audience's sense of immersion in the drama by exploring qualities such as agency and interactivity. [...] In this version, we acknowledge the interactive specificities of digital VR technologies and the role of the user as active; we recognize new opportunities for narrative and give the power of activation over to the end user, whose gaze becomes the spotlight. The user thus embodies the "inquisitor" and is empowered to independently discover the story by looking at the characters and provoking them to speak. [...] A central goal was to address ongoing concerns in the creative cultural sector regarding managing narrative progression in an immersive environment. The solution implemented here operated on the basis that users activated the virtual actors to speak through their gaze. Hence, the artwork acknowledged the new condition of active audiences and recognized new opportunities for narrative by affording audiences a central role in its unfolding. It was believed that by placing the audience at the center of the storytelling process, they were more appropriately assimilated to the virtual world and subsequently empowered to explore, discover, and decode the story, instead of passively watching and listening" (Young, O'Dwyer & Smolic, 2021, p. 594-595).

The V-SENSE project aims to conduct experiments that directly intersect with the fields of art and computer science. From a more directly artistic perspective on approaching volumetric video in the digital arts, we have, for example, the comeback exhibition of MUDA, the Museum of Digital Art, by the Digital Arts Association. After being closed during the pandemic, MUDA's reopening featured a special exhibition by Dirk Koy2, a Swiss digital artist, who poetically investigates the possibilities of volumetric videos in various interactive artworks.

Regarding those mentioned above, streaming gaming and volumetric video are also important tools. Not only does the influencer play the game on screen, but the possibility of accessing the game's environment volumetrically by the viewer

1) More information available at https://www.volograms.com/.
2) More information available in: https://muda.co/dirkkoy/.

enhances the experience, whether they choose to play or not. From another perspective, the interactive drama quality of the game can also be achieved through volumetric video, allowing viewers to attend plays, concerts, and similar events virtually and, to a certain extent, control them directly.

However, although the general use of volumetric video livestreams is possible and successful to varying degrees, it remains largely non-mainstream, with a greater emphasis on exploratory and research-based applications. That is because "Volumetric media transmission involves large amounts of data in order to faithfully represent 3D objects and scenes, several orders of magnitude bigger than traditional images and videos (e.g., a point cloud video with around one million points requires 5Gbps). Thus, considerable effort has been spent in the literature to design, implement, and evaluate algorithmic solutions that would optimize transmission for the end user, limiting the bandwidth consumption without sacrificing the perceptual quality" (Viola; Cesar, 2022, p. 2). Another possibility, recently showcased to the larger public, has been the development and production of volumetric movies. James George, an American computer scientist, has been working for almost a decade on the possibilities of volumetric technologies and their consequential byproducts. Amongst being credited in many works with videometry, George is the co-producer of the film/documentary CLOUDS, the first ever produced using volumetric technology, being "built in C++ using openFrameworks, and includes real-time interactive visualizations by the artists featured in the documentary" (Clouds, 2014). The film premiered at Sundance New Frontier in 2014. It was exhibited at the New York Museum of Modern Art in 2016, with its creators understanding its transdisciplinary nature and its inherent artistic qualities as a project within the digital arts context.

Needless to say, regarding the topics discussed here in this paper, we must also approach the use of such technology in relationships, that is, applied (directly) to the area of virtual games. The technologies are correlated, or even the same as the ones stated here before, therefore, it allows for the contextualisation of their existence and development. Let us then, bring forward some gamified VR examples of such instance; The game "Half-Life: Alyx" (2020), developed by american company Valve, makes use of VR technology, assessed through means of HMDs, like Samsung's Odyssey headset places the player inside of an first-person shooter adventure where the game's main-character has to break their father free of a prison setting. Through the use of not only a 360º setting, as well as haptic feedback, researchers have delved into how the use of VR games, Alyx in specifics, can discuss the relations of able-bodiness, enabling for experiences that are "curative, rehabilitative, and therapeutic. Researchers are currently adapting VR into a diagnostic tool for binocular vision disorders like glaucoma, using VR headsets to monitor the user's visual field" (Jerreat-Poole, 2022, p. 63). Another use of games that have been analysed as to be able to allow us the perception of out-of-the-box uses and experiences of VR technologies are "*Beatsaber*" (2018), "*Pavlov VR*" (2017), "*VTOL VR*" (2017), "*Blade and Sorcery*" (2018), "*The Lab: Slingshot*" (2015) and "*The Lab: Postcards*" (2016). These games, in a specific study, have been used as a means to discover more in regards to bodily autonomy and perception in VR settings by having players experience the applications while laying down, instead of standing up or sitting – as is the norm (Van

Gemert *et al.*, 2023). In regards specific to South American VR games experiences, and related studies of possibilities enabled by the immersion and haptic feedback of the game setting is the game "*Automobilista 2*" (2020), which, with the help of modified and specialised haptic technology and setting has been applied in studies regarding "interaction fidelity and carry-over effects", specifically in its case in regards to bringing forward a sense of motion sickness by replication thanks to sensation fidelity (Alam *et al*., 2023). In a broader aspect we can also note here the existence of the following VR games: "*Resident Evil 7: Biohazard*" (2017); "*Phasmophobia*" (2020); "*The Room VR: A Dark Matter*" (2020); "*Microsoft Flight Simulator's VR*" (2020); "*DCS World VR*" (2018); "*Star Wars: Squadrons*" (2020); "*Boneworks*" (2019); "*The Walking Dead: Saints & Sinners*" (2020). It is also important to highlight that all of these games, of different levels of VR immersion, have been developed and/or released after the half of the second decade of the 21st century.

As we have mentioned before, the fast developments of the 21st century have quickly and increasingly made technology available to the general public. However, the technical specifics and the recent emergence of volumetric videos make it challenging for those outside the convergence of art, science, and technology fields to grasp their creation and/or application, and thus to fully explore other possibilities and innovations. In the realm of digital arts and/or digital games, new experiments and productions have been developed, especially since the 2010s, exploring the limits of genres, technological applications, and the like, not only with videometry, but also with interesting creations regarding the applications of digital visualisation. As stated before, however, it would be difficult to bridge all the necessary gaps to provide our readers with sufficient content to understand the multitude of artistic productions with the technology in focus here. Therefore, we have decided to delve further into the strengths and possibilities created by the convergence of digital art and games, as it is one of the best applications of such technologies in current digital art productions. We will now explain why.

Art and Game Relations

Art and play are both elements that permeate throughout all of humanity, having been an intrinsic part of human culture and history. In this sense, the existence of human beings directly suggests the existence of artistic expression, as evident from the mimetic characteristics of rupestrian productions. Similarly, we can also understand the existence of games as starting even before the induction of social relationships. Dutch author Johan Huizinga, one of the most recognised in literature for his work on game and its history, delves into such discussions in his book *Homo Ludens* (1980), analysing how play has a major importance when it comes to, not only society, but life itself, as he states: "We have to conclude, therefore, that civilization is, in its earliest phases, played. It does not come from play like a baby detaching itself *from* the womb: it arises *in* and as play, and never leaves it" (Huizinga, 1980, p. 179).

Huizinga identifies playing as one of the central aspects of interaction that enables the creation of culture, as it can be observed in other species, such as crows, and how even infants possess the concept of play, not having it (or even having the biological ability to) be taught. Because of such importance,

tied to the existence of human culture, Huizinga compiles some aspects that he considers as essentials for comprehending the possible relations that we find between game and society, highlighting how the act of playing a game is voluntary, delimited in a space/time, with rules, capable of being reproduced, absent of the need for (monetary) profit and happens apart from the daily ordinary life. That is, the author discusses that games are a free activity (even though nowadays some types of game are required by their creators to be purchased), that by not being serious at the same time it "removes" the player from the reality it is inserted into, transporting them to the game's reality (with its own rules and regiment), games can be considered to exist outside of our 'ordinary' life (Huizinga, 1980, p. 13). Modern society, as we understand it, mimics or is heavily influenced by the steps and existence of a game, with its reality being socially constructed according to its cultural rules, creating its own measures of time and space, and constantly being reproduced by its population.

When we analyse games and play in relation to the modern way of life, their impact and relevance continue to hold, even as it is met with technological enhancements, which have been taking place especially since the second industrial revolution, during the 19th century, as society faced changes in its perception of the notion of body, space, and work. Carlos Eduardo Maldonado, a researcher in complexity science, when discussing dynamics in the modern way of living, questions such consequences of the industrial/scientific revolutions, concluding that, currently, it is evident that the act of living is (in) the constant act of processing information (Maldonado, 2020, p. 35). As such, the uncertainty that dominates reality, and by extension digital art, is a demonstration of that, seeing that it has become possible a constant collaboration between different professionals, themes, and techniques, which, at first glance, can be understood as complex but, at the same time, enables various developments – such as that of the digital arts. That is because, in this complex life scenario, art and games become ever so intertwined, considering that, as stated by Pablo Gobira, digital arts consists of a wide range of artworks which "can involve Artificial Intelligence, inorganic systems, or altered organics through genetic engineering, being capable of constituting artificial life forms expressed in an installation, in a performance, or in other manners" (Gobira, 2022, p. 47-48. Translated by the authors).

When analysing current times, the creation and ubiquity of the computer made possible what we understand today as video games, as it constructed the technological base for programing and graphs needed for the development of video games – also commonly known as computer game, regardless of being played in an actual computer of a specific hardware, and as the term we've preferred to use in this paper, digital games. However, the creation of such digital games was not initially a success, as we briefly discussed in the introduction. In 1962, the game known as *Spacewar!* aimed not only to demonstrate the technical capacity of computer technology "but also to attract a general audience. Moreover, this game was not an adaptation of an existing game, but a completely new game designed specifically for the computer" (Piispanen *et al*., 2025, p. 3) showcasing, for the first time in a large scale, how computers could improve the gaming experience.

Computer games are characterised by their interactivity and immersion dimensions, with their development parallel

to computational enhancements, showcasing the eclectic nature of the gaming industry and extending beyond the commonly understood facet of entertainment. One such example is the development of *serious games*, a type of digital game focused on "social impact, solving research problems, educating the general public, and training workers to perform specific tasks on job" (Piispanen *et al.*, 2025, p. 4). In a world surrounded by possibilities, in which "[...] foresight seems highly questionable, if not impossible" (Maldonado, 2020, p. 34. Translated by the authors), digital games are a fundamental tool in culture, tying back into the discussion we brought here on how playing and games have helped create and shape human culture.

The complexity involved in producing, creating, programming, and distributing digital games can be used as a reason not to interpret such creative work as an instance of art. However, by analysing other cases, such as *Desertesejo* (2000), by Gilbertto Prado, we can understand how the blurriness between the fields of game and art makes it more acceptable to the art system. The artwork is created like a sandbox software, enabling interaction between users in a multiplayer online environment, with a chat integrated into its system. The author and the art system understand it, as well as similar creations, as *game art*. If removed from the gallery space where it is exhibited, there is not much difference between a "regular" digital game and an instance of game art. Therefore, we can understand that it isn't due to creative specificities that such terms are applied, but rather by their contextual use, seeing that computer games, with the aided aspects of visual and interactive interfaces, inherently possess the poetic dimension rooted in the arts and artistic creations. Digital games, at large, share similar characteristics to digital art, as the "complexity of the productions of what we call digital arts also reveals itself through multiple characteristics, being that each production (as art) presents its own inherent difficulties/peculiarities (of conservation/preservation, or of the exhibition/circulation, as stated previously)" (Gobira, 2021, p. 35. Translated by the authors), thus demonstrating how the reception in the art system is also a shared element between digital arts and digital games.

Digital games, unlike some other facets of digital arts, have developed their own industry, with particular dynamics that reinforce "the necessity of comprehending the specificities in its wide field and how we can contribute to the recognition of many expressions of digital arts" (Gobira, 2021, p. 36. Translated by the authors). One such way games can contribute to the general understanding of what constitutes digital arts is through digital literacy. The term refers to "[...] the processes of learning (whether formal or informal) that allow people to achieve the digital arts field and its aesthetic production" (Gobira, 2021, p. 30. Translated by the authors). An audience more accustomed to digital games also has, consequently, a better understanding of new technologies, and as such, an affinity with the concept of "interaction", with the idea that there is a need for both software and hardware. Many genres of games exist on different platforms and require different interactions. Thus, such discoveries help prepare users for a more seamless experience with the ubiquitous and non-ubiquitous technological devices we encounter in our day-to-day lives.

The multitude of possibilities brought about by digital technologies has, over the past few decades, enabled various

types of art to emerge with the advent of microcomputers and communication devices worldwide. One of them is the telematic arts. The construction of artworks online redefined the way in which artistic production is made by exploring "procedures and possibilities, [which] not only [include] new machines, but also in brand new work procedures and new relations with these instruments/interfaces" (Prado, 2003, p. 32. Translated by the authors). The telematic arts are particularly interesting for us to approach in this paper, as they inherently require an interactive system mediated by technology. In this paper, based on the discussions we have brought forward on the construction of play and society, we can understand some creations of telematic arts, as well as digital games. One such case, particularly in the Brazilian scenario, where some artists are pioneers in this field, is the artwork *Moone: La Face Cachée de la Lune* (1992) by Gilbertto Prado. It consists of the simultaneous production, in real-time, of digitally generated images between two interactors (or players, when analysed through a gamified lens), each in their own computer, highlighting the need for interaction in the creation of the work. That is, much like "regular" digital games, it can only exist as one or more people play it. Prado emphasises the "[...] ambiguity was at the root of the proposition: a fleeting relation was created in which growth and composition depended on the other, and of the dynamic of exchange" (Prado, 2003, p. 35. Translated by the authors), an almost natural interaction when it comes to computer gaming.

Even with some images of the artwork, *Moone* (1992) suggests tridimensionality, but it does not make use not make use of such technological devices. Given that tridimensionality is necessary when we aim to discuss works of volumetry, it is essential for us also to analyse the existence of such instances when talking about the artistic dimension of games. Thus, we can bring forward some examples that effectively use 3D technologies as part of their work. For instance, we have *NETLUNG: Breath and Blow with Us* (1996), produced by Diana Domingues, Gilbertto Prado, Suzete Venturelli, and Tânia Fraga. NETLUNG consists of a site "with four routes exploring sensorial dimensions" (Nunes, 2022, p. 8. Translated by the authors), each route developed by a respective artist. The experiment with the HTML1 language, aimed "at the symbolic act of breathing in the net, proposing several sensorial routes to explore the interactivity, meanwhile the emulation of the screen inflating and deflating, like a breath" (Nunes, 2003, p. 3. Translated by the authors), added another layer to the worries with the future conveyed by the artists.

Another artist recognised for her use of tridimensionality is Silvia Laurentiz, with her work *Econ* (1999), which is inspired by the poetry of E. M. de Melo e Castro. The work is a "virtual space in third dimension, where the visitor 'walks' through words, establishing new ways to read a poem" (Nunes, 2003, p. 3-4. Translated by the authors). Besides the already mentioned productions, Fábio Oliveira Nunes compiles many artists who participated in this exemplary time for the production of *NetArt* in Brazil, such as "Movemaker, created in 1999 by Rejane Cantoni, tridimensional creation with mentions to op art, enabling variations according to the visitor's interaction with the environment" (Nunes, 2022, p. 4. Translated by the authors).

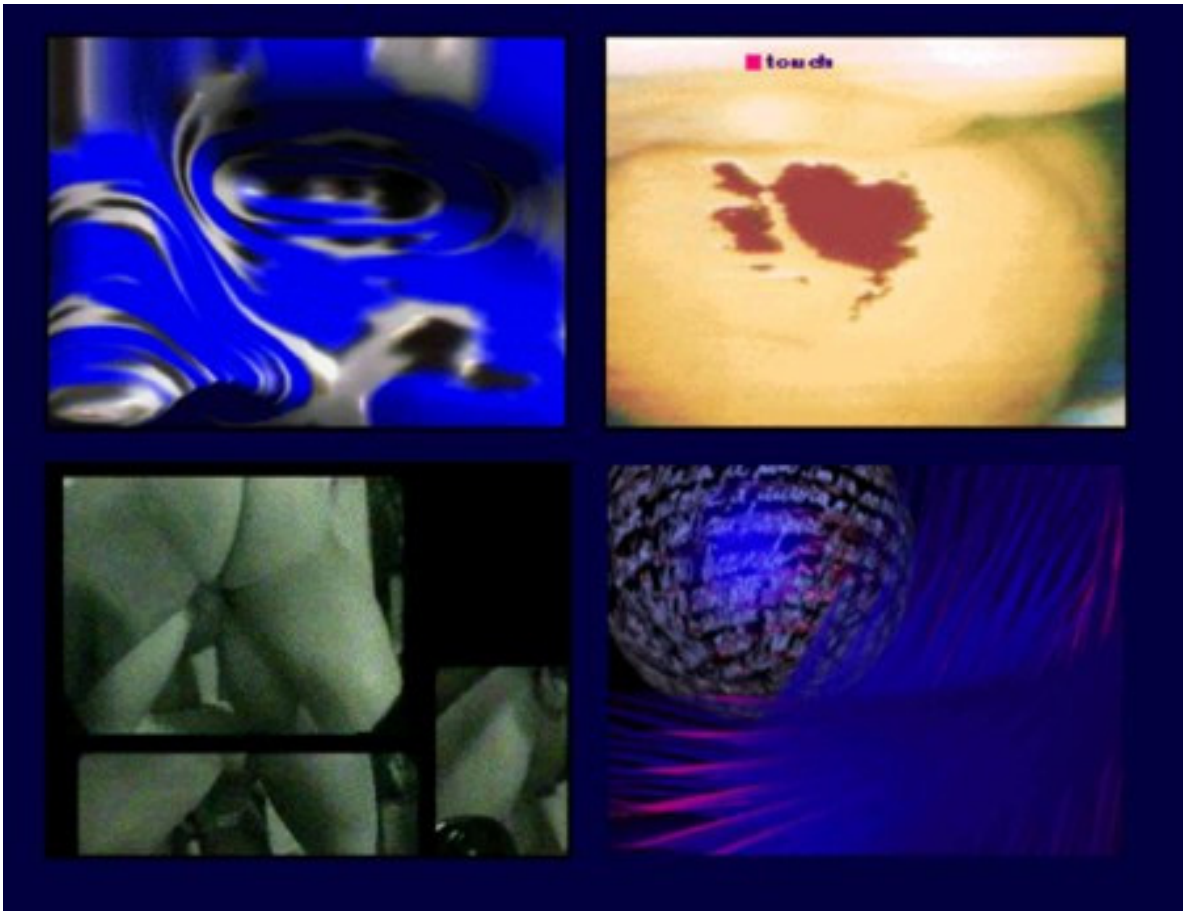

Figure 1 Art piece *NETLUNG (1996)* and images produced by each artist. Source: https://www.fabiofon.com/webartenobrasil/site_netlung.html

It is important to note that, despite the works mentioned here being mainly from the 1990's, the experiments made by artists precede this moment, with "Art-Technology as an artistic manifestation is present in brazilian art since the 1950's, through isolated manifestations from artists like Abraham Palatinik, one of the pioneers in Kinetic Art" (Sogabe, 2019, p. 19. Translated by the authors). The subsequent decades also showed the enhancement not only of the equipment but

also the easiness for creation, considering that "marketing and cheapment of digital equipment, when microcomputers became potent and of personal use" (Sogabe, 2019, p. 26-27. Translated by the authors) allowed a freedom of access to these technologies and equipment. In the 1980's, events like the 17ª Bienal Internacional de São Paulo (1983) the general-curatorship of Walter Zanini "presented in his sector of New Media the event Art and Videotext, organized by Julio Plaza with the participation of many poets and artists of the country; and, under the curatorship of Berta Sichel, an area of works composed of six sectors: cablediffusion, computers, satellite communication, slow-TV scan, videophone and videotext" (Prado, 2003, p. 44. Translated by the authors), demonstrating the consolidation of the computational arts field in Brazil.

The dynamic between art and play has been explored since the earliest days of humanity, gaining notoriety and importance in various eras, whether in rituals, ceremonies, festivities, or conflicts. The entanglement of these two elements persists in many societies, as reflected in music, poetry, and digital games, which serve as a reference to this union.

Final Considerations

It is undeniable that there is a connection between the fields of art, science, and technology in the matter we discussed here. Throughout human history, we have seen cases where the line between them was blurred, ignored, or simply non-existent. With all the heavy technological development that occurred in the 20th century, we witnessed a growth of

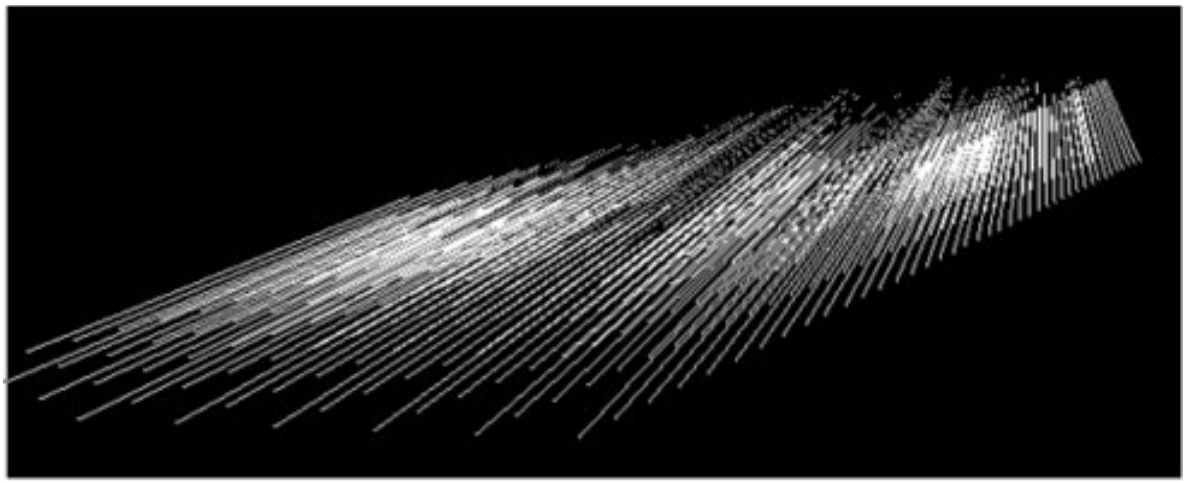

Figure 2 *Movemaker* (1999) by Rejane Cantoni Source: https://www.ufrgs.br/conectartbr/rejane-cantoni-1996-2001

such cases, as now there were the means, apparatus, and techniques to make possible visions of what was previously considered just a future possibility. The creations and discussions in the digital arts, in particular, were significantly enhanced, as the artistic field inherently possesses a poetic dimension that has always enabled artists to think and discuss ahead of their time in terms of technology and science.

When analysing the intersection of art and game, particularly in the current digital era, such productions are not only breaking field norms but also challenging the consensus on what constitutes a game or game art. Through Huizinga, one of the main actors in the discussions of the game field, we are able to analyse and understand how gamified life is, as it is through playing that we construct social and cultural relationships. The potentials of the gamified dynamics of human life were simply explored and exposed more clearly in the digital age. To save the readers' time, we focus only on the human aspect of playing, as it can be extended to plants, animals, and even inanimate objects.

With digital technology ubiquitous in our social existence, hyperconnecting us not only to each other but also to our environment, the gamified explorations have grown consistently clearer. Although indirectly, those experiences have had a significant impact on the current construction of digital games and game art on a worldwide scale. That is because, as we have highlighted in this paper, the interactive narrative, the dramatic aspect of the game's construction – although presented to us by its creators in different levels of complexity – is intrinsic and necessary to the poetic dimension that allows such constructions to exist. In other words, the narrative is a fundamental key to the poetics of a game, as it exists, is created, and is interacted with and played through.

That opens up a door to the player's immersion inside the game, which was previously considered unreachable. "The idea of volumetric video originates from the concept of holograms and 3D real-world virtuals depicted in many science fiction films, such as Star Wars and Blade Runner, where people desire to imitate reality in minute detail without the limitation of the flat screen. The achievement in computer graphics and information processing further empowers the evolution from 2D video to 3D volumetric video" (Jin *et al.*, 2021, p. 1). We are now able, with the help of technological developments, to take a step further in understanding what it means to perceive a game and, consequently, enhance its interactive narrative by allowing players to have greater control over their characters and gaming experience. Not only that, but the technology necessary for volumetric videos also enhances the gamified dimension of other actors, even if they were not originally intended to be understood/read as a gaming instance. For example, the use of volumetric videos in technologically enhanced realities, in plays, in concerts, in movies, and the like thereof changes the viewer into an actor of the developed system, as they now have a more intrinsic control over how the media is not only going to be consumed, but rather how it will be constructed. Such developments have and will undoubtedly continue to change the way in which we interact with games, overall media, applications, with the environment around us, and, ultimately, societally and culturally, with each other.

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