The Enigma A/V performance & the concept of Agnostic Media Environment (AME)

Yan Breuleux[1], Alain Thibault[2], Rémi Lapierre[3]

[1] École des arts numériques, de l'animation et du design, Université du Québec à Chicoutimi
[2] The ELEKTRA International Digital Art Festival, The International Digital Art Biennial (BIAN)
[3] École des arts numériques, de l'animation et du design, Université du Québec à Chicoutimi
Montréal, QC, Canada
yan_breuleux@uqac.ca atelektra@gmail.com lapierre.remi@gmail.com

Abstract

The occupation and reappropriation of industrial wastelands has become a part of the digital art festival scene. In some cases, new apparatuses are introduced, while in others, existing architecture is utilized for artistic purposes. Many cities and municipalities offer artists historically significant projection surfaces that shape the conceptualization of immersive art projects. In this context, multiple large-scale installation projects have emerged with the recent growth of the experiential creative industries sector. Against this backdrop, the present article raises the issue of a specific experience-design practice in the field of audiovisual (A/V) performance. More precisely, we examine a proposed conception process to help bring about a better understanding of cross-platform production approaches. The question we ask is: In the artistic context of the ever-changing digital arts, how can we account for the multiplicity of possible appearances of the same artistic project? To answer this question, we present the storytelling of the Enigma project and explain how producing a matrix of 3D environments, which can be deployed on a very wide variety of media, supports the proposal of the Agnostic Media Environment (AME) concept.

Keywords

Immersive Storytelling, Extended Reality (XR), Spatial Augmented Reality (SAR), narrative environments, multi-platform, video mapping, FullDome, A/V performance, Agnostic Media Environment (AME).

DOI

10.69564/ISEA2023-44-full-Breuleux-et-al-Agnostic-Media-Environment

Introduction: the experiential industries

This article is written from the standpoint of examining a conception process as opposed to a reception process. As such, the article is located at the boundaries of practical and theoretical aspects (practitioners and theorists)[1,2] of immersive storytelling in relation to an A/V performance practice deployed on multiple display systems.[3] For many years this practice has been evolving within digital art festivals, which program works drawing on a wide variety of projection mediums. Numerous visual music festivals, such as Mutek (CN), Elektra (CN), Live A/V (IT) Nemo (FR), Scopitone (FR), and the Mapping Festival (CH), to name just a few, make use of industrial wastelands, introduce their own projection systems and use the facades of existing places.[4] Laboratories, such as the MetaLab of the Society for Arts and Technology,[5] are developing innovative new tools for artists in order to stimulate creativity in the field of immersive experience design.[6] For example, the MAPP_MTL organization, in the entertainment district of the island of Montreal, provides artists with historically charged surfaces that shape the conceptualization of their works.[7] Also worth mentioning is the recent phenomenon of largescale exhibitions such as the *Atelier des Lumières* in Paris[8] and the *Oasis* of the Palais des congrès de Montréal.[9] The evolution taking place within these media environments has raised a research question: In the artistic context of the ever-changing digital arts, how can we account for the multiplicity of possible appearances of the same artistic project? To answer this question, we will begin by tracing the origins of the practice of A/V performance and how it connects with environments in the mixed reality spectrum of extended reality (XR).[10] Next, based on analysis of the Enigma cross-platform art project, we will define the theoretical contours of this article's main proposal, i.e., the concept of Agnostic Media Environment (AME). Our hypothesis is that it is possible to design an informational matrix composed of 3D environments that can be adapted to an infinite number of projection surfaces and installations.

A/V performance community of practice

The practice of A/V performance has its roots in the many forms of sound visualization,[11] from colour organs[12] to experimental film and video and the emergence of multimedia that have shaped the practices of visual jockeys (VJ).[13] The launch of this practice dates to the mid-1990s and the immersive scenographies featured in the performances of the Granular Synthesis duo, made up of artists Kurt Hentschlager and Ulf Langheinrich. The duo left their mark on the A/V performance field with the multi-screen performance *Model 5* (1994-2007).[14] In spite of the existence of a vibrant and active community of practice since the midnineties, the designation of Performance A/V or Live A/V only really became established in 2010 with a special issue of the journal *Musique et culture digitale* (MCD, 2010) that cited numerous performing artists.[15] That same year, Chris Salter published the book *Entangled: Technology and the Transformation of Performance* in which he situated this current at the crossroads of the performative arts of theatre and dance. In describing the performances of Granular Synthesis, he used the term "performative screens."[16] Grayson Cooke for his part characterized this practice as "Live audio-visual media performance" [17]. Other terms include "Digital Live Audiovisual Arts" (DLAA)[18] or simply "Live visuals".[19] The field has been enriched by such noted artists as Rioji Ikeda, Ryoichi Kurokawa, Herman Kolgen, Carstein Nicolai, and Matthew Biederman. To this list should be added artists using the same language elements in installation format, such as Can Buyukberber, Refik Anadol, Robert Seidel and Chris Salter. Collectives and studios have also joined in this trend with the label AntiVj (which gave rise to the studio of artist Joanie Lemercier), Purform, Ottolab, Incite, and Semiconductor. In the tradition of Kraftwerk's large-scale POP electronic music audiovisual performances, it is also worth mentioning the immersive installations of Amon Tobin and Richie Hawtin, aka Plastikman. Many artists in the A/V performance community of practice are interested in various forms of sound visualization.[20] These audiovisual performances, delivered in renowned festivals such as Mutek (CN) and Elektra (CA), are presented on multiple projection-screen scenographies. The underlying artistic principle, which animates the community of practice of this sector of the creative industries, is located mainly in cross-modal practices that involve the use of various technologies of editing or real-time visual and sound form generation. The Limeart content-creator group has published several posts on their blog reviewing real-time video creation tools, under the title "mega list of Vj Software and Vj tools." Without presenting an exhaustive list, these tools can be classified into different categories.[21]

Live Visuals	Visual programming	Creative coding	Bridge
Module 8	Touch Designer	Processing	Spout Syphon
Resolume	vvvv	Open Framework	
VDMX	Notch	Cinder	
MadMapper	Isadora		
Arkaos	Max Msp/Jitter		
	Vuo		
	Spark		
Game Engine: Unreal Engine, Unity			

Table 1: A/V Performance Tools

As Table 1 illustrates, the tools most commonly used by the A/V and VJ performer community of practice are classified as live visuals, node-based environments and creative programming tool kits. In addition, interoperability solutions are used to allow various software to talk to each other. For example, the Spout (PC) or Syphon (Mac) applications now let users create procedural animations in Touch Designer that will be displayed within the Unreal Engine and Unity game engines (and vice versa). The particularity of game engines is that they incorporate live visual tools and visual programming for creative coding approaches. Thus, all of these tools merge data capture, real-time video computation and projection technologies on a diversity of systems within a single technological environment. For the purposes of this article, it is worth noting that the intermediate solutions of visual programming and creative coding include tools for procedurally generating virtual environments that allow the use of a VR headset.

The SPARK (Spatial Augmented Reality Construction Kit) real-time visual solution produced by TecArtLab is the closest to the research subject of this article.[22] The LimeArtGroup describes the tool as being used to create an "immersive interactive spatial augmented reality installation."[23] The software is a "cross-platform tool" for "real-time generated virtual content."[24] The user can design a "360° VR environment no matter the shape of your surfaces."[25] The current progression of game engines suggests many possibilities in this area. The SPARK software is based on a 3D matrix form that can be used on multiple systems.

Real-time visual creation software is increasingly using real-time 3D rendering engines. What these engines have in common is the ability to synchronize, capture, real-time computation and projection technologies across multiple platforms, from the web to virtual reality to various multiscreen configurations. To designate these practices of using visuals in real time for screen scenographies, Chris Salter, in line with the approach of expanded cinema, uses the expression "the Screen as Environment."[26]

The environmentalization of the image

The research presented in this article is based on the observation of Andrea Pinotti, from the field of immersive experience composition, that there has been a shift away from the notion of image and toward environment, what he terms "environmentalization of the image."[27] In an immersive context—unlike a two-dimensional image—the space occupies the viewer's entire field of view. The framing disappears in favour of the environment, which, in its modeling, becomes the narrative architecture. In video games, Henry Jenkins has addressed this aspect with the concepts of environmental storytelling and spatial stories.[28] For Janet H. Murray, this aspect is inherent in the use of digital technologies: "The new digital environments are characterized by their power to represent navigable space."[29] These navigable digital spaces are now finding their equivalent in the real world. It is no coincidence that Marie-Laure Ryan has explored this question from several angles in literature. In her book *Narrating Space / Spatializing Narrative*, she analyzes the relationship between geographical space and literary fiction.[30] In the entertainment industry, Disney illustrator Don Carson analyzes the concept of environmental storytelling for theme park design. The narrative dimension grows out of the very experience of the space. In Carson's own words: "One of the trade secrets behind the design of entertaining themed environments is that the story element is infused into the physical space a guest walks or rides through."[31] In fact, the notion of spatial experience embedded in the space itself is at the core of theme park literature as developed by Scott A. Lukas.[32] Based on this same notion, Tricia Austin, in exhibition architecture, has precisely analyzed the relationship between narrative environments and experiential design. His model, "The tripartite network model of narrative environments," is rooted in the relationships between people, environments and stories.[33] On this subject, Stephanie Riggs draws no distinction between virtual and physical reality. In her book *The End of Storytelling*, she proposes the concept of *Storyplex*. In interactive exhibition design, she describes a shift from the paradigm of cinematic framing to the sphere of interactive environments.[34] To sum up, the multidisciplinary literature on the subject examines how spatial modeling influences the shaping of

narratives. In this context, the notion of narrative environment situates the research at the boundaries of the physical and the virtual.

Spatial Augmented Reality (SAR) in the Extended Reality Continuum (XR)

The boundaries between the virtual and the real are precisely the location of the concept of XR (extended reality) interfaces or the equivalent term of Cross Reality.[35] This term has proven necessary in order to update the reality-virtuality continuum as proposed by Milgram and al. in 1994.[36] The spectrum is an umbrella term covering what David Bolter calls "reality media"[37] such as virtual reality (VR), augmented reality (AR) and virtual worlds (VWs).[38] Although the approach is not mentioned in the literature, A/V performance practices can be situated within XR: the field of optics includes a Spatial Augmented Reality (SAR) sector.[39] Bimber and Raskar, in their book on optical technologies, describe setups such as Automatic Virtual Environments (CAVE), panoramic, architectural video mapping and FullDome spherical screens as "surround screens." The knowledge contained in SAR optics has its origins in the oldest forms of immersion, harking back to puppeteers' illusionist play of shadow and light, anamorphic paintings, and the camera obscura, up to the celebrated Pepper's Ghost.[40] Many SAR devices rely on the same principles of syncing video projection to create projected environments adaptable to multiple spaces. What is involved here is augmented spatiality since these systems exploit anamorphic vision processes to erase, use, and "hijack" the multiplicity of projection surfaces to create illusionist spaces. The space is transformed by the artificial amplification of surfaces, the animation of virtual lights, the creation of faux spaces and the transformation of geometric spaces into curved surfaces. SAR devices allow for erasing the notion of screen in favour of the screen environment. By adapting digital content to architectural environments, objects and bodies, these optical processes virtualize real space. In turn, this virtualization of space enables the creation of collective immersive experiences that transform the exhibition space into an interactive environment. For example, the TeamLab Borderless creative studio creates projection museum environments where the boundaries between architecture and projector light merge within the same ambient space.[41] Largescale museum installations thus become material environments transformed by the use of virtual light. In short, the notion of a screen environment specific to A/V performance using SAR technologies in an XR context opens avenues for considering the projection of the same project across multiple platforms.

Methodology

Figure 1: *Enigma* Multiplatform Project from 2017 to 2022. Multiscreen, Elektra, Usine C, Montréal, 2017. HD, Festival Nemo, La Villette, Paris, 2018. FullDome, Society for Arts and Technology (SAT), Montréal, 2019. Horizontal panorama, Elektra, Centre Culturel Canadien, Paris, 2020. Streaming HD, Galerie Elektra, Montréal, 2021. Circular Panorama, Coraulis, Ensa, Nantes, 2022. © Breuleux

Our methodology is located within the creation-as-research approach as defined by Chapman and Sawchuk.[42] Following the method of heuristic cycles put forward by Louis-Claude Paquin,[43] we propose to look at how the projection of the Enigma project across multiple devices, conceived from the outset as an agnostic environment, has helped define the contours of the concept. As Figure 1 shows, our research, conducted between 2017 and 2022, consisted of storytelling that emerged from the different iterations of the Engima project. In this method, each new iteration further refines the theoretical contours of the proposed concept.

Enigma A/V performance storytelling

The *Enigma* project is based on the world of famed mathematician Alan Turing, and seeks to create an experience inspired by the technological/scientific imaginary surrounding artificial intelligence.[44] The project explores the transposition of the notions of encryption and cryptography to a poetic exploration of the famed mathematician's thinking.[45] The experimental space is based on a combination of nine sound visualizations projected in the form of environments: 1- data, 2- speech to text, 3- amplitude; 4-frequencies; 5- 3D shapes 6- illustration sequences 7- Hardware of the computer 8- point clouds 9- word clouds. Environments are modified in real time using a touch interface allowing the user to change the parameters of deformation, temporality, object quantity and camera viewpoints.

As shown at the first photo of Figure 1, the first multiscreen version in 2017, featured as part of the Elektra festival, consisted of an installation simultaneously showing the nine visualizations of composer Alain Thibault's musical score on a 3X3 grid of 55" monitors. The second version, created in 2018, featured a single-screen HD format that distributed the nine visualizations over time according to a new 35-minute musical composition. In 2019, we adapted the linear performance into FullDome format. Each section of the piece was presented as a dive into procedural three-dimensional forms.

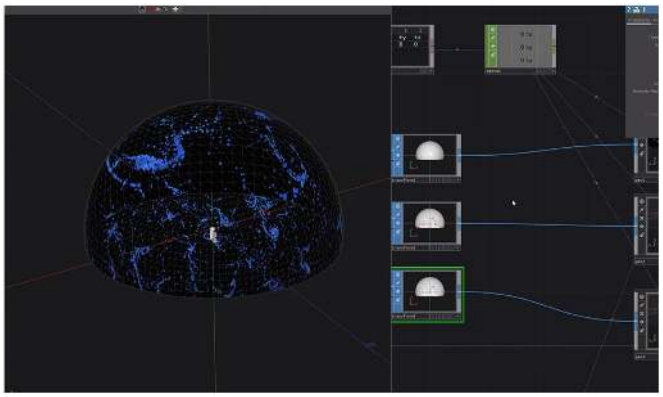

Figure 2: 210° capture of the previz system. © Lapierre.

Thanks to its initial structure, the project made it possible to move from a two-dimensional screen format to hemispherical projection surfaces. We used a virtual reality (VR) preview system to design the scenario for the workshop performance (figure 2). Subsequently, the 2020 dual-screen panoramic version of the Canadian Cultural Centre in Paris was adapted in a few hours. For the 2021 streaming version, amid lockdowns, in order to configure the piece for a new performance context, we added networked tools that allowed for broadcasting directly on the YouTube platform. The 2022 version was adapted to the system of the centre d'Observation en Réalité Augmentée et Lieu d'Immersion Sonore (Caurolis) de l'École Nationale Supérieure d'architecture de Nantes (ENSA).[46] The next iteration of the Enigma project will tap into the expressive potential of the motion capture system to create a control interface projected in the centre of the installation.

Each new iteration is created thanks to the arrangement of the cameras within the environment (single camera for the HD version, nine cameras for the multi-screen installation, 210° FullDome camera for the Satosphere dome, etc.). Multiple camera synchronizations allow for quickly configuring visualizations within procedural environments to generate new versions on site. As an example, the figure 3 is based on the random movement of nine cameras inside a 3D environment. Each screen is a particular point of view of the same reality.

Figure 3: Nine views of the same 3D environment. © Breuleux

Given the dynamic relationships between the objects and the music, the duration of the environments as well as the transformation parameters can be manipulated. The Enigma project consists of a series of 3D environments. As such, each projection and translation of the experience for a new setup affords an opportunity to reinvent certain elements of the project.

To summarize the project approach, each installation offers an opportunity to renew the project experience. However, one important aspect must be stressed: each experience is stand-alone in its presentation. There is no real dialogue between the different iterations. In other words, for the *Enigma* project, despite the variety of manifestations of the same project, each new version constitutes a work in its own right.

The 3D Agnostic Media Environment (AME)

The concept of 3D Agnostic Media Environment (AME) was coined to address a particular workflow guided by the need to adapt each project to the expressive potential of multiple projection contexts. In software terminology, “agnostic” refers to the process of automated adaptation to different devices and operating systems. A website, for example, will recognize the resolution of a phone, a tablet model, or a type of web browser. These constraints are relatively simple since the two-dimensional viewpoint of smartphones remains relatively stable. When it comes to the match between real and virtual spaces, the logic of adaptation is more complex. For FullDome projection domes alone, there are 180° and 210° projection angles, single and multi-channel projection solutions, as well as multiple projection systems. In contrast to movie theatres that use standardized systems, planetariums rely on a wide variety of systems and standards [48]. Generally speaking, the AME concept is a response adapted to the ecosystem of the experiential sector in which each new projection demands a degree of reinvention of the project components.

The proposed concept of agnostic 3D environment emerging from analysis of the narrative of the different iterations takes the shape of a world of aesthetic and experiential rules that can be transposed on multiple Spatial Augmented Reality (SAR) platforms. The term “media environment” is used insofar as each new version helps gradually establish an eco-system conducive to communicating information. To summarize in basic terms: By staging the viewpoints, AME exploits the specific expressive potential of each new apparatus.

The 3D agnostic media environment approach determines a workflow. Considered from a production rather than reception perspective, the term “agnostic” takes up the logic inherent to responsive and adaptive design web approaches in which, from the outset, the content is imagined according to its multiple permutations. The agnostic environment thus appears as a space of language governed by aesthetic rules that organize the visual, sound and interactive dimensions.

According to the diagram in Figure 4, AME, unlike software, has forms that possess a certain stylistic signature with respect to rhythm, composition, lights and camera movements. Sometimes, the experience is delivered only once on a site-specific basis. The environment, because it can be configured and manipulated in real time, makes it possible to operate the projection system as an instrument.[47] In the succession of procedural environments, the design of interactions between the sounds and visuals are part of the organization of the digital material.

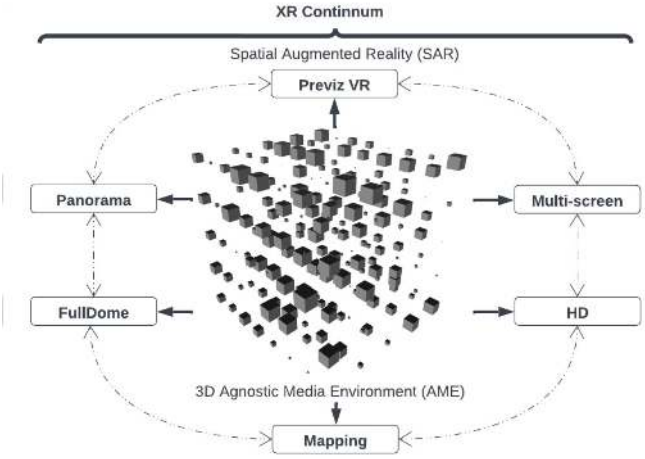

Figure 4: The Multiplatform AME Model. © Breuleux

Each new installation requires some reorganization of the experience. Depending on the context, it will be necessary to change the display parameters and recompose the elements. Adaptations are made through the virtual reality (VR) preview format of the experience. For example, for several AME projects, a satosphere-scale VR dome was used to validate the formal elements of performances. Thus, the idea is not just to automatically transfer information from one platform to another, but also to leverage a preview environment to be able to modify the control parameters, the scale of the shapes, and the points of view according to each medium. The agnostic environment also opens avenues for exploring apparatuses that were not included in the original media environment. For example, architectural video projection entails a process of on-site intervention specific to a particular facade. To stage the experience, it will be necessary to take the expressive potential of the location and the façade into account.

AME is therefore not associated with any one particular tool. Rather, the approach confers an aesthetic unity shaped by the physical, temporal and technological conditions of the different contexts. The AME principle can be reformulated by designing a “spatial story path,” organized according to a certain duration and which, to construct the experience, exploits the expressive potential of the stimulation technologies specific to each new apparatus.

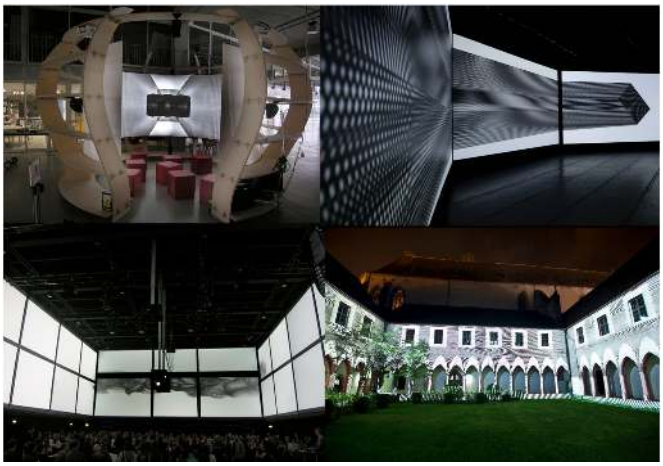

Figure 5: *White Box* versions from 2011 to 2012. Circular Panorama, ENSA, Nantes, 2011. Multi-screen, Elektra, Place des Arts, Montréal, 2011. Rectangular panorama, Elektra, La Gaîté Lyrique, Paris, 2011. Video mapping, Les Dominicains de Haute Alsace, Guebwiller, 2012. © Breuleux

The AME approach was forged to make explicit a workflow in A/V performance (as the *White Box* project, at the figure 5, from 2011 to 2012, show). This article was written to systematize practical knowledge for research purposes in order to demonstrate that cross-platform creative approaches exist in the experiential industries. In addition to the *Enigma* project, the AME system has been used for multiple artistic creations such as *Mapping Me* (2018), *Les Planètes* (2018), *Illumination Frankenstein* (2018), and *Nuages/Clouds* (2022). This last project was based on the creation of multiple narrative environments exploring the metaphor of the cloud and driven with a tangible interface.

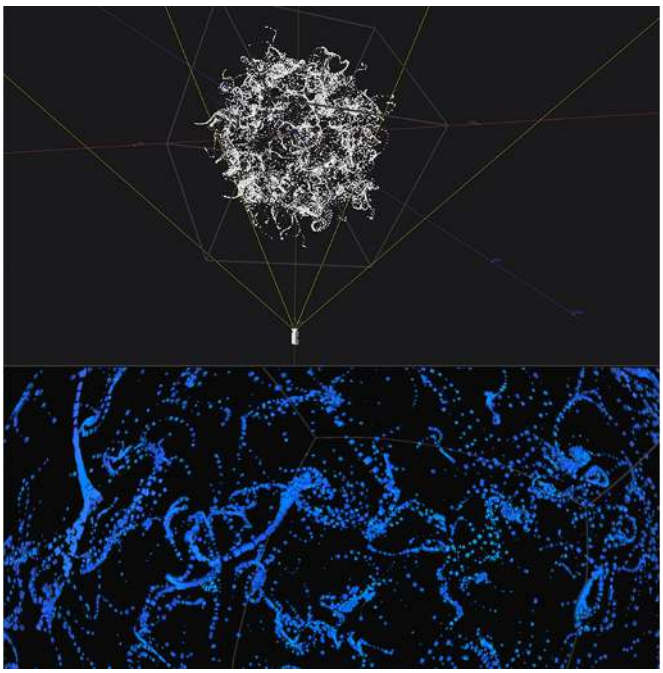

Figure 6: The FullDome camera and the realtime view. © Lapierre.

Captured within the *Enigma* project, figure 6 shows two perspectives of the same system. This image demonstrates how environmental storytelling does not sublimate the idea of the point of view. In this sense, during the continuous design process for these projects, we composed, arranged, and organized the visual narrative using a succession of scene-environments. For example, in figure 7, the camera is moving inside a complex information network. Unlike in a film, in this sequence of different spaces each spectator can choose their own point of view. Therefore, the proposal of the AME concept for SAR creations aspires to highlight the notion that, in the XR paradigm, it is necessary to stop thinking in terms of *surface* but rather *volume*. In the production process, abandoning the frame in favor of a virtual environment accommodates the infinity of possible perspectives afforded by various forms of displays.

Conclusion

Whereas the cross-media,[49] remediation,[50] transmedia,[51] spreadable media,[52] and intermedia[53] approaches have been the subject of extensive entertainment literature in the video game [54] and film sectors, the definitions of the various terms from communication research and literature only partly reflect the actual practice of A/V performance mentioned in this article.

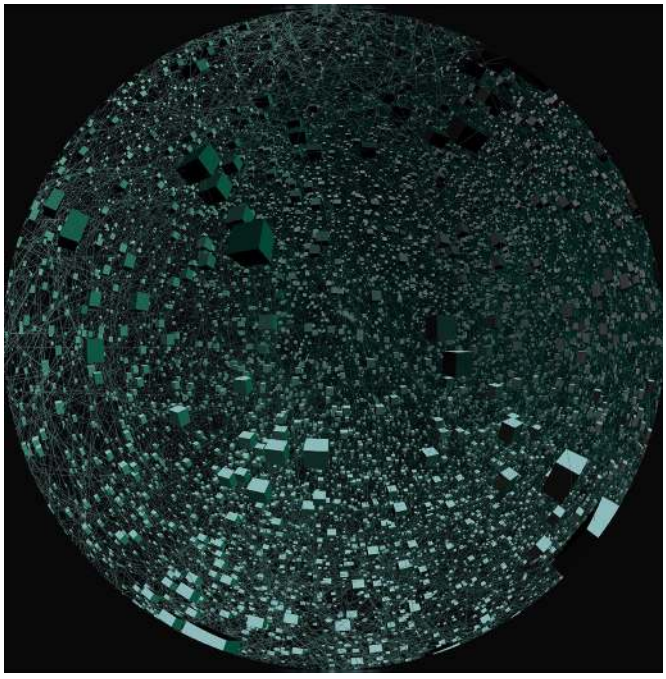

Figure 7: Inside a FullDome realtime environment. © Breuleux, Lapierre.

The convergence that has emerged from the multimedia web[55] has prompted a reconfiguration of the roles and processes of publishing and distributing information via multiple platforms. The realities that gave rise to the terms of Cross Media, Transmedia and Intermedia do not account for the realities in A/V performance. For example, when moving from a nine-screen installation to a FullDome experience, some content remediation takes place based on the specificity of the medium. Contrary to the transmedia approach, these two iterations do not aim at generating a global experience or enriching it with new dimensions. Each new immersive experience of the *Enigma* project is a standalone translation with its own transmission codes. The definition of transmedia also entails the participation of fans and users in the dissemination process. A transmedia media environment, according to Henry Jenkins, is also about how a single individual organizes their consumption of information: "New technologies are enabling average consumers to archive, annotate, appropriate, and recirculate media content."[56] On the contrary, the AME concept is based on a production and not consumption logic; a logic of creation and not reception. This paper has also addressed the situated conception of narrative environments. To summarize, the immersive A/V performance experience- design research sector requires terms tailored to the realities of design and production.The AME concept was devised to respond to issues of cross-platform SAR artistic design and production for the experiential industries. As the potential for procedural generation, processing, and projection rises with the rapid advancement of real-time rendering technologies in game engines and nodal programming environments, it becomes possible to envision multiple types of AMEs. The concept is in fact a way of organizing information for the creation of immersive experiences.

In conclusion, taking the systemic logic of the proposed AME concept a step further, each environment matrix will be available online via a multi-user WebGL app that will let the user adapt artistic creations to the growing number of technology apparatuses along the XR continuum.

Beyond the technical dimensions, the proposal of the concept of agnostic environment aims to better understand the processes of immersive experiences creations in the digital arts sector. This reflection makes it possible to study, via the transversal concept of environment, the dynamic relationships between the materiality of XR reality technologies and the virtuality of the narrative immersive experiences. The AME approach therefore facilitates the design of multisensory immersive experiences deployed on multiple platforms.

References

1 Kerrison, Margaret Chandra, "The immersive storyteller : writing for real and imagined worlds," Studio City, CA, Michael Wiese Productions, 2022.

2 Gröppel-Wegener, Alke, Jenny Kidd, "Critical encounters with immersive storytelling," In. New York, NY, Routledge, 2019.

3 Festival Elektra, "Le marché international des arts numériques (MIAN)," accessed november 21, 2022, https://www.elektramontreal.ca/pro?lang=fr

4 Festival Mutek, "Mutek Forum," accessed november 21, 2022, https://montreal.mutek.org/fr/forum

5 Société des Arts Technologiques (SAT), (2022)," website, accessed October 27, 2022, https://sat.qc.ca/

6 Société des Arts Technologiques, "Rétrospective des innovations de la SAT! (2022)," Metalab website, accessed October 27, 2022, https://sat-mtl.gitlab.io/metalab/timeline/

7 "Quartier des spectacles," website, accessed October 27, 2022, https://www.quartierdesspectacles.com/fr/medias/MAPP-MTL

8 "Atelier des lumières" website, accessed October 27, 2022, https://www.atelier-lumieres.com/

9 "Oasis," website, accessed October 27, 2022, https://oasis.im/

10 Stanney, Kay M., Hannah Nye, Sam Haddad, Kelly S. Hale, Christina K. Padron, Joseph V. Cohn, *Extended reality (xr) environment, in handbook of human factors and ergonomics*, 2021, 782-815.

11 Daniels Dieter, Sandra Naumann, Jan Thoben, Lentos Kunstmuseum Linz., Ludwig Boltzmann Institut Medien.Kunst.For-schung., and Linz 2009-Kulturhauptstadt Europas Organisations (Firm), "See this sound: audiovisuology compendium: an interdisciplinary survey of audiovisual culture", Köln, Germany, Verlag der Buchhandlung Walter König, 2010.

12 Kenneth J. Peacock, "Instruments to Perform Color-Music: Two Centuries of Technological Experimentation," Leonardo 21, 1988, 397-406.

13 Michael Faulkner, and D-Fuse, VJ: audio-visual art + VJ culture, London, Laurence King, 2006.

14 "*Granular Synthesis,*" group website, accessed October 27, 2022, https://granularsynthesis.info/MODELL-5

15 Anne-Cécile Worms, "Live A/V, performances audio-visuelles, hors-série," MCD, Musiques et Cultures Digitales, 01/04/2010.

16 Chris Salter, *Entangled: technology and the transformation of performance*, Cambridge, Mass., MIT Press, 2010.

17 Grayson Cooke, "Performing archival remix in Outback and Beyond," International Journal of Performance Arts and Digital Media 11 (1), 2015, 100-115.

18 Marie-Eve Bilodeau, Ghyslain Gagnon, Yan Breuleux, "NUAGE: A Digital Live Audiovisual Arts Tangible Interface." ISEA2022 - ISEA International, Barcelone, 2022.

19 Steve Gibson, Live visuals: history, theory, practice, Routledge advances in theatre & performance, Abingdon, Oxon, New York, Routledge, 2022.

20 Knight-Hill, Andrew, "Sound and image: aesthetics and practices," In Sound design. New York, Focal Press, still image, 2020.

21 Limeartgroup, " The mega list of VJ Software and Tools (2020)," accessed november 21, 2022, https://limeart-group.com/the-mega-list-of-vj-software-and-tools/

22 Tecartlab"SPARCK," website, accessed November 27, 2022, https://tecartlab.com/features/

23 Limeartgroup, "The mega list of VJ Software and Tools (2020)," accessed november 21, 2022, https://limeart-group.com/the-mega-list-of-vj-software-and-tools/

24 Limeartgroup, " The mega list of VJ Software and Tools (2020)," accessed november 21, 2022, https://limeart-group.com/the-mega-list-of-vj-software-and-tools/

25 Limeartgroup, " The mega list of VJ Software and Tools (2020)," accessed november 21, 2022, https://limeart-group.com/the-mega-list-of-vj-software-and-tools/

26 Chris Salter, Entangled: technology and the transformation of performance, Cambridge, Mass., MIT Press, 2010.

27 Andrea Pinotti, "Towards an-iconology: the image as environment," Screen 61 (4), 2021, 594-603.

28 Henry Jenkins, “Game Design as Narrative Architecture,” Electronic Book Review, July 10, 2004.

29 Janet H. Murray, "Hamlet on the Holodeck." In. Riverside: Free Press, 1997, 61.

30 Marie-Laure Ryan, Foote Kenneth E., Azaryahu Maoz, Narrating space/spatializing narrative: where narrative theory and geography meet, Theory and interpretation of narrative, Columbus: The Ohio State University Press, 2016.

31 Don Carson, “Environmental Storytelling: Creating Immersive 3D Worlds Using Lessons Learned from the Theme Park Industry (2000),” Game Developer (aka Gamasutra), accessed November 2022, https://www.gamedeveloper.com/design/environmental-storytelling-creating-immersive-3d-worlds-using-lessons-learned-from-the-theme-park-industry

32 Scott A. Lukas, "The immersive worlds handbook: designing theme parks and consumer spaces," In. Burlington, Mass.,Focal Press, 2013.

33 Tricia Austin, "Narrative environments and experience design: space as a medium of communication," In Routledge research in design studies, New York, Routledge, 2020.

34 Stephanie Riggs, The End of Storytelling: The Future of Narrative in the Storyplex: Beat Media Group, 2019.

35 Stanney Kay M., Hannah Nye, Sam Haddad, Kelly S. Hale, Christina K. Padron, Joseph V. Cohn, "Extended reality (xr) environments." in handbook of human factors and ergonomics, 2021, 782-815.

36 Paul Milgram, Haruo Takemura, Akira Utsumi, Fumio Kishino, 1994, "Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum." Telemanipulator and Telepresence Technologies, 21 December, 1995.

37 Maria Engberg, Jay David Bolter, "The aesthetics of reality media," Journal of Visual Culture 19 (1), 2020, 81-95.

38 Cindy Ziker, Barbara Truman, Dodds Heather, "Cross Reality (XR): Challenges and Opportunities Across the Spectrum." In Innovative Learning Environments in STEM Higher Education: Opportunities, Challenges, and Looking Forward, edited by Jungwoo Ryoo and Kurt Winkelmann, Cham: Springer International Publishing, 2021, 55-77.

29 Bimber Oliver, Ramesh Raskar, Spatial augmented reality: merging real and virtual worlds, Wellesley, Mass.,A K Peters, 2005.

40 Huhtamo Erkki, Illusions in motion: media archaeology of the moving panorama and related spectacles, Leonardo book series. Cambridge Massachusetts: The MIT Press, 2013.

41 "Team Lab Bordeless", website, accessed November 27, 2022, https://www.teamlab.art/e/borderless_azabudai/

42 Owen Chapman, Kim Sawchuk, "Research-Creation: Intervention, Analysis and “Family Resemblances,” Canadian Journal of Communication 37 (1), 2012, p.5-26.

43 Louis-Claude Paquin, “Faire de la recherche-création par cycles heuristiques (2019),” Louis-Claude Paquin archives, accessed, November 22, 2022, http://lcpaquin.com/

44 O. Vinyals, Le, Q., A neural conversational model, 2015, arXiv preprint arXiv:1506.05869.

45 Purform: Alain Thibault, Yan Breuleux, accessed November 22, 2022, https://vimeo.com/225283585/0455f3796c

46 l'École Nationale Supérieure d'architecture de Nantes (ENSA) "CORAULIS (Centre d’Observation en Réalité Augmentée et Lieu d’Immersion Sonore)," accessed November 22, 2022, https://www.nantes.archi.fr/lensa-nantes/coraulis/

47 Yan Breuleux, “Le dispositif de diffusion comme instrument (2019),” in, Quéinnec, Jean-Paul, Giusy Pisano, Jean-Marc Larrue, and Scholars Portal, Dispositifs sonores : corps, scènes, atmosphères, Espace littéraire, Montréal Quebec, Presses de l'Université de Montréal, 2019.

48 Edward Lantz, "Immersion Domes" In Handbook of Research on the Global Impacts and Roles of Immersive Media, 2020, 314-346.

49 Niklas Odén, "Mechanisms within cross media stories : An analytical framework combining cross media phenomena with storytelling elements", 2013.

50 J. David Bolter, Richard A. Grusin, *Remediation: understanding new media,* Cambridge, Mass.,MIT Press, 1999.

51 Henry Jenkins, "Transmedia Storytelling and Entertainment: An annotated syllabus," Continuum 24 (6), 2010, 943-958.

52 Henry Jenkins, Sam Ford, Joshua Green, Spreadable media: creating value and meaning in a networked culture, Postmillennial pop, New York, London, New York University Press, 2013.

53 Bruhn, Jørgen, Beate Schirrmacher, Intermedial Studies, 2021.

54 Marie-Laure Ryan, *Narrative across media: the languages of storytelling*, Frontiers of narrative, Lincoln, University of Nebraska Press, 2004.

55 Henry Jenkins, *Convergence culture: where old and new media collide*, New York, New York University Press, 2006.

56 Henry Jenkins, *Fans, bloggers, and gamers: exploring participatory culture,* New York, New York University Press, 2006, 1.

Authors Biographies

Yan Breuleux (M.A.Sc, D.Mus) is an associate professor at École NAD-UQAC UQAC (École des arts numériques, de l'animation et du design), co-researcher within the Hexagram network, the Mimesis laboratory and a practitioner in the field of visual music for immersive devices. He designs A/V performances in the form of sensory experiences.

Alain Thibault has been presented in several contexts, contemporary music and digital art events, in America, Europe and Asia. He is the director of ELEKTRA an annual festival showcasing performances since 1999 and the International Digital Art Biennale, oriented towards exhibitions since 2012.

Rémi Lapierre has a background in art and science through his studies in mathematics, programming and video games. His multidisciplinary profile allows him to understand both the advanced technical issues of software design and the expressive logics of digital creation. Rémi is currently working in the automated generation of virtual environments for immersive devices.