POST-PRINT: GRAPHIC DESIGN AND AUGMENTED REALITY

REAL-TIME INTERACTIVE 3D CONTENT
IN PRINTED GRAPHIC DESIGN POSTERS

MASTER'S DEGREE IN COMMUNICATION DESIGN
NOVEMBER 2019, ESAD MATOSINHOS

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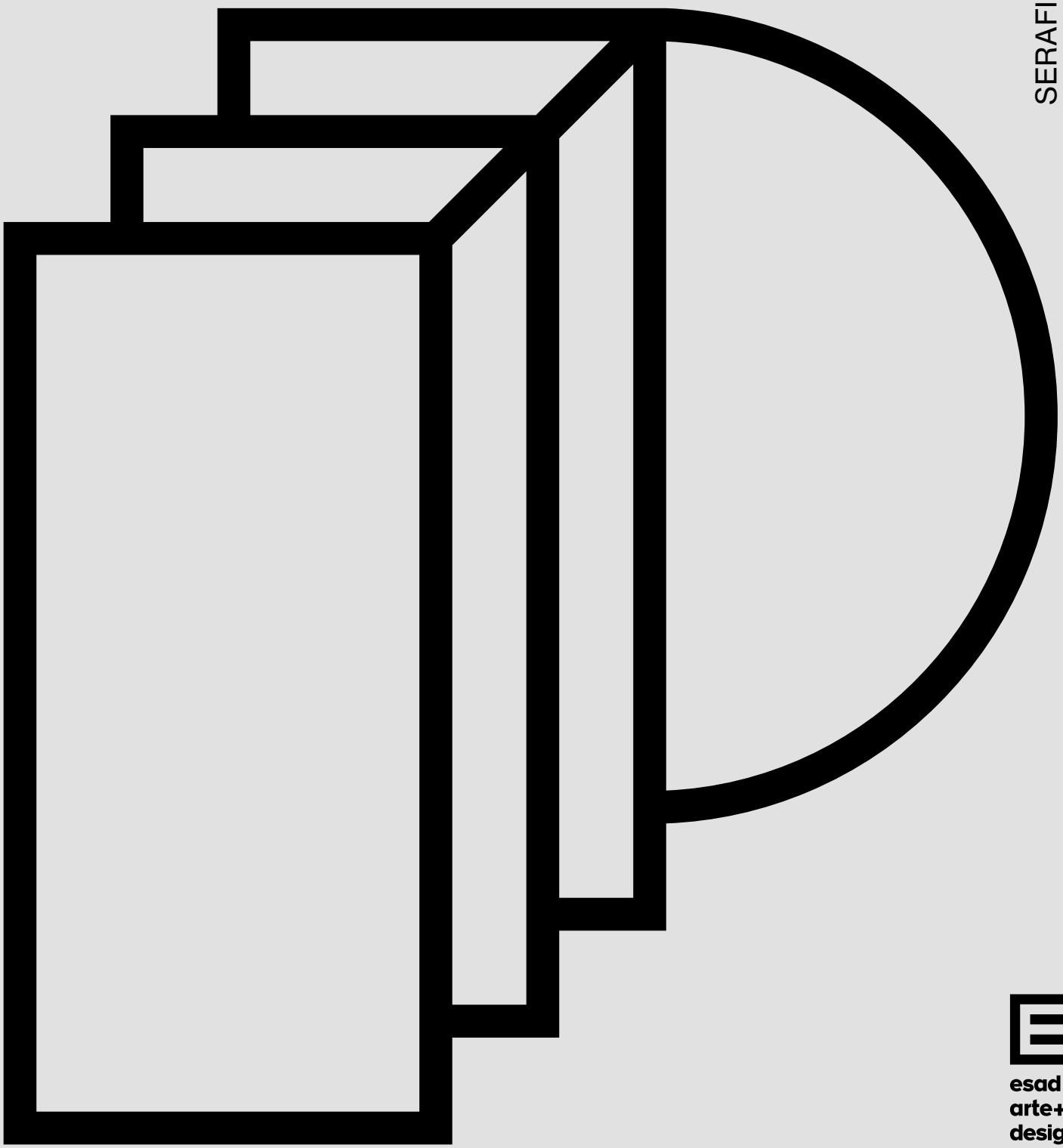
THESIS COORDINATOR: ANA RAPOSO



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ABSTRACT

This project stems from the desire to combine interactive 3D content, technology and graphic design. Augmented Reality (AR) allows us to merge digital content and information with our physical world, in 3D space. While there is a multitude of ways to experience augmented reality, this project restricts its exploration to mobile hand-held devices, such as smartphones and tablets. It aims to explore this upcoming medium, in an attempt to leverage our existing 3D content creation knowledge in the development of multiple AR experiences that share the same medium — the printed poster. Done from a designer rather than a developer perspective, it focuses on the exploration of graphic possibilities enabled by the use of this medium and its underlying technology, in order to understand what can be done and how it can be done, given current limitations. The project does not delve too deeply into complex interactions, focusing on the basics of AR. This experimentation results in a cross-platform mobile app that enhances a series of fifteen printed posters through animation in three dimensions, culminating in an interactive exhibition where the viewer can control how the content is seen. The report includes an overview of previous AR and design projects aiming to understand what has already been done, as well as projects that derived from this one, which demonstrate how this knowledge can be applied in real world scenarios. The results indicate that there is still much leeway for further exploration that due to technical barriers will gain from collaboration between designers and developers for the creation of meaningful experiences that take full advantage of this medium.

Keywords: augmented reality, graphic design, interactivity, mobile app, poster

RESUMO

Este projeto surge de uma vontade de combinar conteúdo 3D interativo, tecnologia e design gráfico. A realidade aumentada (RA) permite-nos juntar conteúdo digital e informação ao mundo físico, em três dimensões. Apesar de existirem várias maneiras de experienciar realidade aumentada, este projeto foca-se unicamente na exploração de dispositivos portáteis, nomeadamente os smartphones e tablets. Tem como objetivo explorar este novo formato, numa tentativa de alavancar conhecimentos pré-existentes de criação de conteúdo 3D para o desenvolvimento de múltiplas experiências RA the partilham o mesmo suporte — o cartaz impresso. Feito de uma perspetiva de designer gráfico em vez da de um programador, o projeto foca-se na exploração das possibilidades gráficas que advém do uso deste formato e da tecnologia subjacente, de forma a entender o que é possível fazer e como pode ser feito dadas as limitações técnicas existentes no momento da sua execução. O projeto não aborda funções tecnológicas avançadas que pressupõe conhecimentos avançados de programação, focando-se em interações básicas da RA. Esta experimentação resulta numa aplicação móvel multiplataforma que complementa uma série de quinze cartazes impressos através de animação em três dimensões, culminando numa exposição interativa onde o utilizador consegue controlar a forma como o conteúdo é visto. O relatório inclui uma visão geral de projetos que combinam RA e a prática de design de forma a entender o que já foi feito, bem como projetos que derivam deste, para demonstrar como estes conhecimentos podem ser aplicados num contexto real. Os resultados indicam que ainda existe muito a explorar dada a curva de aprendizagem acentuada e barreiras técnicas que têm a ganhar através da colaboração entre designers e programadores para a criação de experiências significativas que tiram proveito completo deste formato.

Palavras-chave: realidade aumentada, design gráfico, interatividade, aplicação mobile, cartaz

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INTRODUCTION

This project, under the title *Post-Print*, aims to combine interactive 3D content, graphic design, typography and animation through the use of Augmented Reality (AR) in mobile hand-held devices, such as smartphones and tablets. For the purpose of this project AR was the logical choice because of its real-time relationship with the printed artifacts, instead of completely replacing our visual world with a virtual one, as is the case with VR. Even though Augmented Reality (AR) has been under development for several decades now its use has become more widespread and available to the masses during recent years in diverse fields, including graphic design.

Three dimensional computer-generated images (CGI) have been used in graphic design for several years, however it has become more and more common for designers and/or illustrators to integrate them in their practice and toolkit. Advances in computation power in consumer-grade hardware, allied with easier learning tools and use of 3D content creation software, have given individuals the possibility of creating on their personal computers extremely high quality images, known as renders, that used to imply higher costs and the access to expensive hardware or multiple computers. This democratization of 3D has changed the way many creatives approach image creation. Combining this with the fast-paced advances in Augmented Reality (AR) and Virtual Reality (VR) industries opens up a whole new world of possibilities for designers, hopefully adding meaning and usefulness to the fact we are working in three dimensions.

The main goal of *Post-print* is to introduce an interactive 3D layer into printed artifacts, through a visual and technical exploration of mobile AR, culminating in a final exhibition. It involves not only the development of a cross-platform mobile application but mostly the understanding of content creation for this medium.

The printed support chosen was the poster since it allows for faster experimentation of multiple ideas. It is important to keep in mind that this project does not aim to work within a conceptual approach but to explore the graphic and technical possibilities that arise with the combination of AR and graphic design.

It is important to keep in mind that, from start to end, it is done from the perspective of a graphic designer with no background or previous experience in mobile application development and not a programmer/computer engineer. As such, this report does not delve too deeply into the technological side and, for the sake of brevity, the technical concepts covered are the ones that affect content creation directly, covering what I consider a graphic designer should know for getting started in AR. This is fundamentally a study of how content can be designed for these experiences, instead of a report on what exactly is happening technologically under the hood.

This written report does not intend to be a step-by-step guide to the creation of augmented reality experiences. The technology behind AR is constantly changing and evolving. On the other hand, the core principles behind this medium remain constant, so the report focuses on the thought process behind the design and development of these AR experiences, in an attempt to reveal some of its possibilities and limitations.

Due to the fast changing nature of technology, the biggest source of information for technical development comes from online communities and forum boards where people are actively discussing the latest technological breakthroughs. Book research was fundamental to understand the definition, context and history of augmented reality.

This document is divided into five chapters. Chapter 1, *Contextualization*, starts by introducing the definition and brief history of augmented reality, followed up by the concept of real-time rendering and hand-held (mobile) AR. The chapter also introduces AR's basic functionality for a quick understanding of how these experiences come together in a mobile application. Additionally, I list some of the existing tools and platforms that allow the creation of AR experiences, which were considered during the process or some released at a later stage, but are considered relevant.

Chapter 2, *Existing projects*, presents some of the projects that combine AR and Graphic Design, in order to understand what is currently being made around the globe.

Chapter 3, *Technical and graphical considerations*, introduces limitations that arise while working with this medium, which were encountered during the process. These limitations affect how we create, animate and display content. I also present hints on how to optimize the content so that it doesn't waste computational resources. Since they have direct impact on the content, they are considered important from a designer's perspective, in order to be able to properly create experiences that work smoothly on a wide range of devices.

Chapter 4, *Process*, outlines the project execution: deciding the printed medium, early experimentation, introduction of the tools used, defining the project's name and identity, means of online communication (website and instagram), typeface contributions from several type designers and type foundries, the final results with notes and considerations, app design decisions and the exhibitions.

Chapter 5, *Derivative projects*, showcases national and international projects that involve AR and Graphic Design. These projects were initiated during and due to this exploration and it's online exposure. I was involved in all of them, either in content creation, or both content creation and app development.

1. CONTEXTUALIZATION

1.1. AUGMENTED REALITY: DEFINITION AND BRIEF HISTORY

The problem is augmented reality is largely thought of as a technology. If you ask someone to explain what augmented reality is, inevitably they will do so by describing the components: a camera, a display, positional sensing sensors. It's like telling someone what time it is by describing how to build a clock. (Peddie, J., 2017, p. 53)

This chapter will introduce the definition and brief history of augmented reality, as well as basic technological aspects regarding the underlying technology that are important to keep in mind while projecting and preparing content for these experiences.

According to Alan Craig (2013) augmented reality is not a technology but a medium, and one must think as such in order to create useful and meaningful experiences. AR may be considered as a real-time view of a physical environment that has been augmented by adding virtual, computer generated information to it. Borko Furht (2011) adds that AR can affect the user's sense of reality by overlaying virtual elements upon the real world in real time. With AR, the digital information appears to become part of the real world in the user's perception. These experiences can be accessed through multiple devices, such as desktop displays, head-mounted displays (HMD), handheld displays, projector-based displays, and stationary displays. This project focuses solely in AR viewed through mobile handheld displays: smartphones and tablets.

The idea behind AR is rumoured to origin from the computer scientist Ivan Sutherland's 1965 essay *The Ultimate Display* but in 1997 a more concrete definition was provided by Ronald Azuma. Azuma (1997) defines the technology that enables AR as having the three following properties:

1. It combines both real and virtual.
2. It provides a degree of interactivity in real time.
3. It works and is registered in three dimensions.

In 1968, Sutherland was responsible for the development the first head-mounted display (HMD) (Fig. 1), a device to be placed on the user's head, containing a small optical display. The same year Sutherland created what is believed to be the first AR experience, The Sword of Damocles, with the help of his student Bob Sproull.

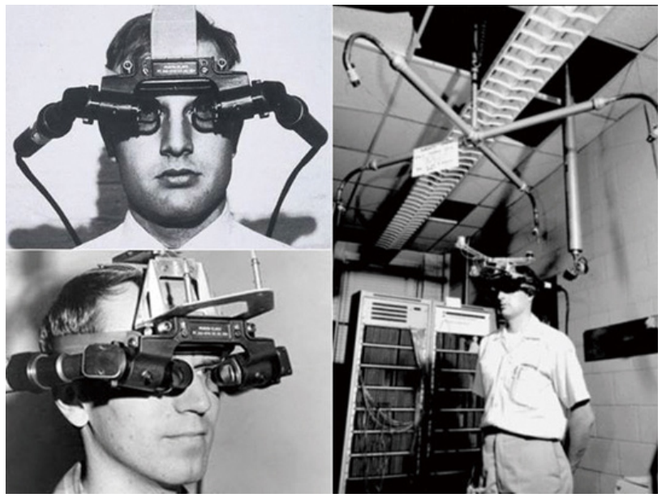


Fig. 1 – Head-mounted display by Ivan Sutherland.
Retrieved March 5, 2019 from *https://animagalaxy.com/ar-vr-mr/item/359-augmented-reality*

This device was quite primitive in terms of both realism and user interface, where the graphics were composed by simple divisions presented in a wireframe format, a three dimensional representation formed by lines and vertices. Over time, the technology matured and arrived to the performative arts and entertainment areas. In 1994, Julie Martin created the first theatrical production that used AR, entitled *Dancing in the Cyberspace*, which featured acrobats who danced in and out of virtual objects placed in the physical stage.

Steven Feiner (2002) claims that researchers at *Boeing* – a north-american multinational corporation for aerospace development and defense – coined the term Augmented Reality back in 1990. They presented the term as:

This technology is used to "augment" the visual field of the user with the information necessary in the performance of the current 15 task, and therefore we refer to the technology as "augmented reality". (Caudell & Mizell, 1992, p. 3)

Until then, AR research was only available to a few institutions and corporations due to its high costs and hardware requirements, such as HMDs and computers powerful enough to process the graphics needed for the augmented experiences. Furthermore, the algorithms used for computer vision were closed sources and unavailable to anyone outside these companies' research labs.

The release of *ARToolKit* in 1999, an open-source computer-vision based tracking, enabled researchers from around the world to create augmented reality experiences. *tv* was developed by Dr. Hirokazu Kato, released by the *University of Washington HIT Lab* and represents one of the first mobile AR software development kits (SDK). It used square fiducials (AR markers) and a template-based approach for recognition. Together with the proliferation of mobile devices with higher computing capabilities and advanced features, it opened the doors for cheaper and faster development of AR experiences.

Currently there are multiple SDKs available in the market to choose from. In April 2011, Qualcomm announced the release of its AR platform software development kit (SDK) – *QCAR*. It is now known as *Vuforia* and owned by *PTC*, and is the SDK used in this project's final result. Some other examples include *ARKit* (*iOS*) by *Apple* and *ARCore* (*Android*) by *Google*.

Although AR and VR terms are often interchanged, they are not the same thing. However, they share some of the underlying technology (Peddie, 2017). The main difference between AR and Virtual Reality (VR) is the fact that the first merges digital information with the real, physical world, while the last immerses the viewer in a purely virtual world (Steuer, 1992).

Dieter Schmalstieg and Tobias Höllerer (2016) claim that the complete freedom provided by the replacement of our world with a digital one, using the VR medium, can prove to be a limitation. They claim "*the limitation comes from the main interest we have in our daily life, which is not directed toward some virtual world, but rather toward the real world surrounding us.*" (Schmalstieg & Höllerer, 2016, p. 32) Having this in mind, the choice of mobile AR for this project was made taking into account accessibility, possible usefulness, and day-to-day integration.

1.2. REAL-TIME VS NON-REAL TIME RENDERING

Rendering is the process of automatically converting 3D meshes to a final 2D image or sequence of images (Fig. 2).

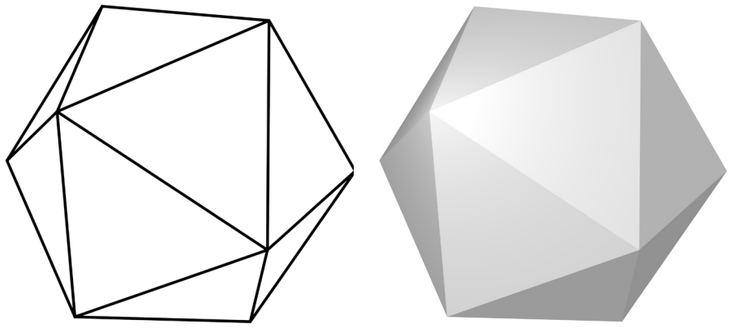


Fig. 2 – 3D mesh (left) and rendered 2D image (right).

Depending on the process used, these renders can be either photorealistic or non-photorealistic. The renders can be done in real-time, usually for interactive content such as games or AR/VR experiences, or non-real time as for example in visual effects in movies, where a single frame can take hours or days, depending on the complexity of the scene.

This project assumes that non-real time rendered 3D imagery – often used in graphic design projects – is not taking full advantage of the extra dimension as these renders, despite being able to provide a sense of depth and sometimes a high degree of photorealism, are still limited outputs. They are created in a 3D environment, yet they are seen through 2D screens/prints and force the viewer into a perspective chosen by the designer and/or illustrator. If that content is animated it is possible to increase the illusion of depth, but if the content is pre-rendered the viewer has no control over it as it is not interactive.

In the 2017 white paper by Ventuz Technology, *Real-time Rendering: An introduction*, the rendering process is summed up as *"objects* [that] *are specified by describing their surfaces using points in 3D space and triangles connecting those points"* (p. 3). They add that "since everything is constructed out of triangles, there also simply is no "smooth" surface" (p. 3), which means that to give the illusion of a perfectly rounded and smooth object, we have to increase the polygon count until it appears smooth (Fig. 3).

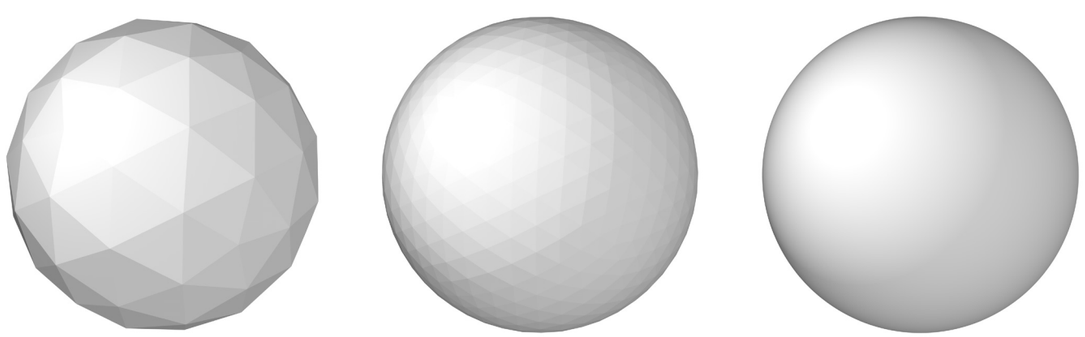


Fig. 3 – Icosahedron spheres: low (left), medium (center) and high (right) polygon.

This, of course, affects performance as there are more polygons to be calculated before the image is outputted. Thus it is important to find a balance between look and performance.

The exact definition of real-time rendering is not consensual. Some would affirm that that rendering 5 frames per second (FPS) is considered real-time, but in the context of this project we assume that for a fluid experience, we need a minimum of 24 FPS. In other words, the outputted image has to refresh twenty four times in one second.

Real-time rendering with AR and VR brings new options to the table. Instead of rendering the content in advance, it is calculated in real time and in 3D space, aligned with our physical world. This allows for a truly interactive experience in which the viewer is able to control how they see it by freely orbiting around the animated 3D content. Exploring the creative possibilities enabled by the use of this real-time technology is the premise behind *Post-print*.

1.3. HAND-HELD MOBILE AUGMENTED REALITY

From the different display devices for AR, this project focuses on mobile devices. It's a subset of AR defined as Hand-held Mobile Augmented Reality (HMAR).

Mobile AR allows the integration of information in the physical world through the device's screen resulting in a video see-through (VST) experience. This is achieved by using the back-facing camera of a smartphone or a tablet, devices that a significant part of the population owns and carries with them on a daily basis (Fig. 4).

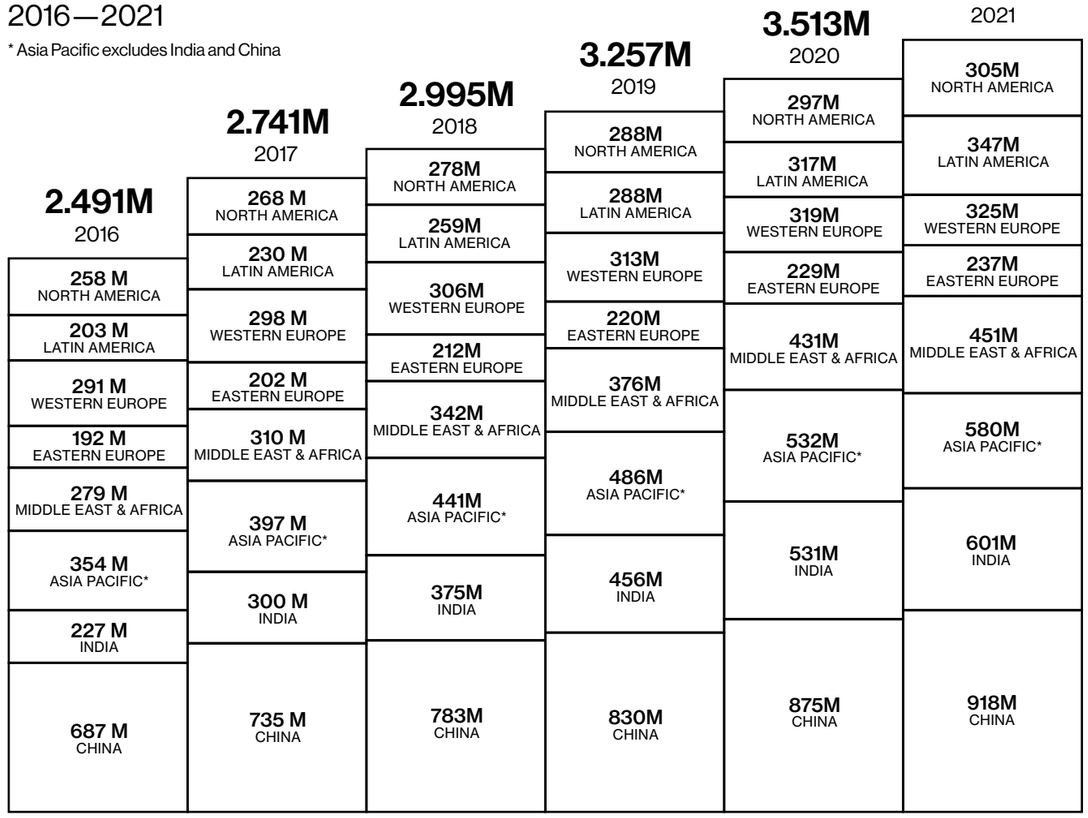


Fig. 4 – Newzoo projects 3.8 billion smartphone users by 2021 (adapted).

The constant development in AR's underlying technology combined with the proliferation of more advanced mobile devices is making mobile augmented reality a commonplace. They are currently the most common AR display (Schmalstieg & Höllerer, 2016).

"In many ways, enhancing mobile computing so that the association with the real world happens automatically seems an attractive proposition. (...) Augmented reality holds the promise of creating direct, automatic, and actionable links between the physical world and electronic information." (Schmalstieg & Höllerer, 2016, p.32)

No exact definition was found during this study regarding the differences between HMAR at the other AR systems. Some studies have used Milgram's continuum (Milgram, Takemura, Utsumi, & Kishino, 1994) to group HMAR with other AR and VR systems (**Fig. 5**).

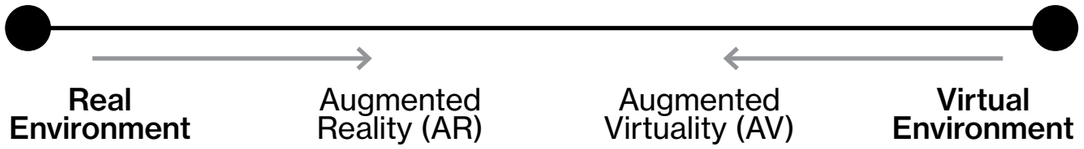


Fig. 5 – Milgram's Reality-Virtuality (RV) continuum aids in the definition of mixed reality environments that use a display to show real and virtual objects together, going from entirely real, on the left to entirely virtual, on the right.

Feng Zhou , Henry Been-Lirn Duh and Mark Billinghurst (2008) claim that mobile devices are good alternatives to HMD systems, *"because they are minimally intrusive, socially acceptable, readily available and highly mobile"* (p. 198). On the other hand, Lawrence Rosenblum, Steven Feiner, Simon Julier and Edward Swan (2012) disregard HMAR entirely as *"hand-held form factors, despite much of the hype they are receiving now, simply are not adequate"* (p. 445). Despite this claim hand-held mobile augmented reality has been growing steadily over the years. Having started in the 1990s as mere prototypes, it has now become a part of the day to day of the masses, either by games like *Pokemon GO!* to social media, as is the case of the augmented reality filters available on *Snapchat, Instagram, Facebook*, and other social networks and apps.

1.4. AR BASIC FUNCTIONALITY

"In Augmented Reality, the computer uses location, motion, and orientation sensors and algorithms to determine the position and orientation of a camera. Augmented reality technology then renders the 3D graphics as they would appear from the viewpoint of the camera, superimposing the computer-generated images over a user's view of the real world." (Peddie, J., 2017, p. 53)

The technology behind AR experiences involves a wide variety of fields and study areas. It depends on the type of experience we're creating.

In this project, the experiences are based on the tracking of Image Targets, consisting of printed design artifacts. Contrary to VR, Augmented Reality mixes the digital with the real world and, as such, accurate positioning of virtual objects becomes crucial for compelling interactions. Since I am using physical, printed images as targets, one expects to have a fluid experience when interacting with these, otherwise it will break the illusion of 3D. Consider a printed poster with overlaid 3D elements using augmented reality. If we walk close to it, we expect it to react accordingly: the perspective and scale should adapt as we move. If the objects starts moving at a wrong angle, or starts shaking when we are holding our device still, the experience is not satisfactory. There are certain design requirements to improve image stability, explained further ahead in this report.

While the general user can't usually explain why an AR experience isn't working well technically, they are able to detect if something is wrong in a matter of seconds when it isn't convincing enough. (Peddie, 2017).

1.4.1. Tracking, calibration and registration

Tracking is the dynamic determination of spatial characteristics over time, more specifically, the use the display device camera to measure the position and rotation of an entity, such as a marker, target, human face, object, among others (Schmalstieg & Höllerer, 2016). Tracking can also be done with *"optical sensors, GPS, accelerometers, solid state compasses, wireless sensors, etc."* (Fuhrt, 2011, p. 35) but, in the context of this project, only tracking through the mobile device camera is taken into account. The 3D virtual objects are placed in alignment to the real world, by tracking cameras.

Three terms are used to describe this process: tracking, calibration and registration. For general understanding, we will briefly introduce these concepts.

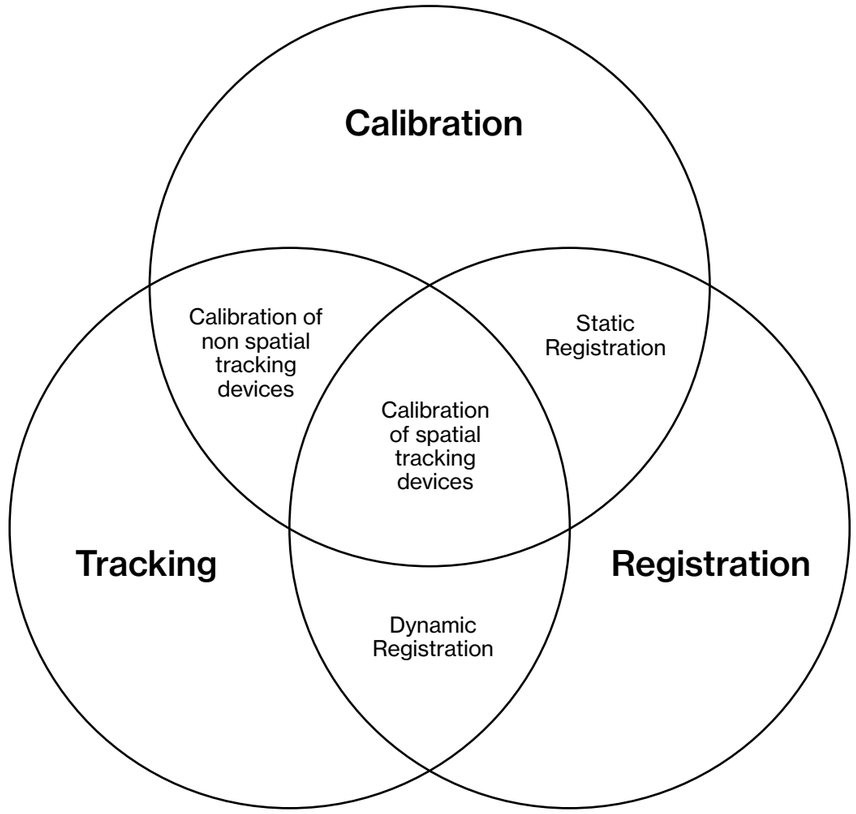


Fig. 6 – An AR system must address three important, overlapping concepts: tracking, registration, and calibration (adapted). Retrieved from Schmalstieg & Hollerer (2016).

While tracking describes the dynamic measuring of AR systems, registration makes use of that information for accurate positioning of the content in space. The virtual objects are aligned to each other and with the real world, using a common coordinate system (Holloway, 1997). As mentioned before, a good and fluid AR experience should have accurate positioning and rotation of the objects to ensure the illusion of 3D space in the user's perception.

Calibration compares measurements between two different devices: a reference device and an uncalibrated device. It is used for static registration, which happens when the display device is not moving. When the device is moving dynamic registration is required, which uses tracking (Schmalstieg & Hollerer, 2016).

1.4.2. Markers and targets

Different tracking techniques were developed and tested parallel to AR development, from mechanical devices, ultrasonic devices, magnetic sensors, GPS, compasses and optical sensors. An optimal solution was never found, but as cameras on mobile devices got better – smaller sensors and higher resolutions – due to their proliferation, better and cheaper vision-based techniques appeared. (Peddie, 2017)

It is also possible to create AR experiences that do not require targets, also known as markerless or spatial AR. These are the most challenging ones technologically, but simultaneously the most promising (Bimber & Raskar, 2005), since they are able integrate the digital content seamlessly in our world without using a specific visual reference. While it is positive to understand the general concept, this project does not explore markerless tracking.

I will now briefly analyse the different type of vision-based targets. *When ARToolKit* was released as open-source, it was common practice to use fiducial markers (Fig. 7) consisting of black and white square images with a black thick border for easy computer vision recognition. Due to their simplicity, fiducial markers were able to deliver good results with low computational requirements and worked well even with poor camera quality. (Schmalstieg & Hollerer, 2016)

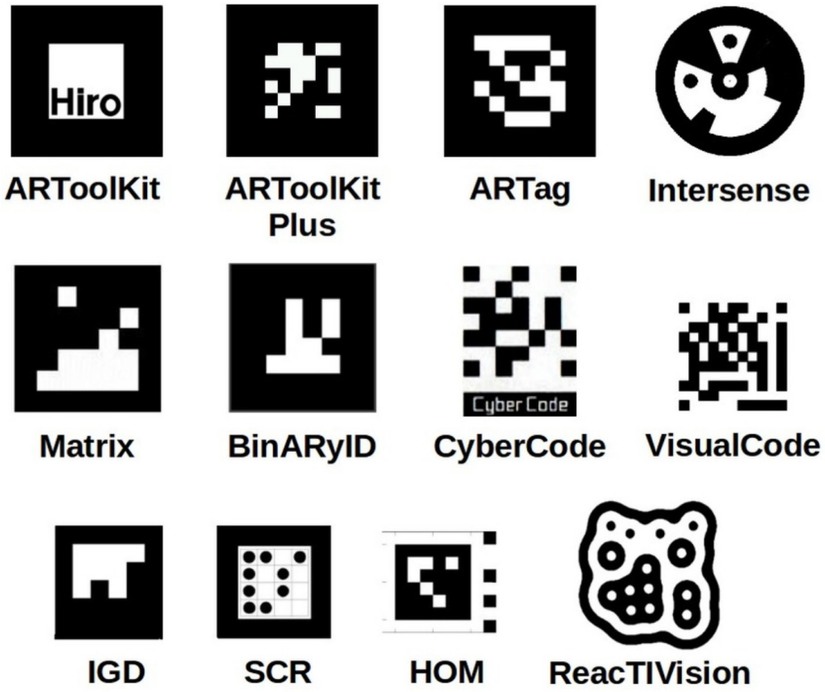


Fig. 7 – Examples of fiducial markers. They serve as real world anchors of location, orientation and scale, which help create a stable and accurate fusion of real and synthetic imagery.
Retrieved from Garrido-Jurado, Muñoz-Salinas, Madrid-Cuevas & Marín-Jiménez (2014)

Tracking can also be done using image targets that are not fiducial markers. The image is converted to grayscale and its natural features generate reference points (Fig. 8) also known as keypoints (Schmalstieg & Hollerer, 2016) that are tracked by the computer vision algorithm. This is the tracking method used in this project, where printed artifacts become image targets.

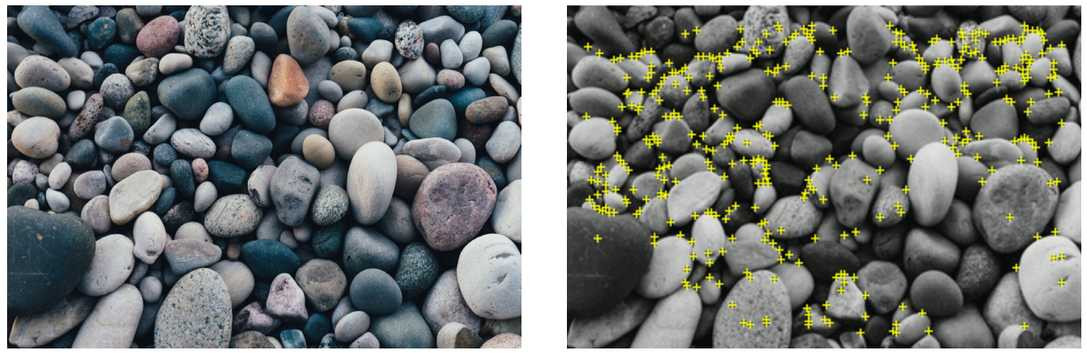


Fig. 8 – Left: original image by Scott Webb (retrieved from Unsplash). Right: interest points. (generated using Vuforia Target Manager).

Unlike fiducial markers, these images don't require special black and white regions or codes to be recognized by the computer vision algorithm. The image's natural features are compared against a known target resource database. They not only require better image quality – in comparison to fiducial markers – but also higher computational power and as such have only become popular recently (Schmalstieg & Höllerer, 2016). Upon being detected it is tracked as long as the image, or part of it, is visible by the device's camera. A higher number of reference points results in smoother tracking that is also more tolerant to image occlusion. It is also possible to track basic 3D shapes, such as cubes and cylinders and custom 3D shapes, providing there is a digital model to integrate in the AR application target database.

1.5. TOOLS FOR CREATING AR EXPERIENCES

Unlike the early days of AR there are currently several available resources to create augmented experiences from platforms that allow the creation of simple AR experiences without even seeing a single line of code to tools that allow the development of fully customized mobile applications.

1.5.1. Software as a Service platforms

The Software as a Service (SaaS) platforms that were experimented with during this project are described below. There are more services available, however they are not covered in this report because they did not offer as many options regarding content - such as lack of interactivity options or the inability to import animations as intended - and/or had a higher cost of usage in comparison to the ones mentioned here. The platforms below also offer browser based content creation and/or standalone applications.

Layar, founded in 2009, is a service that offers quick and easy augmented reality in printed supports. It allows embedding videos, audio clips, interactive slideshows and links to physical supports. It does not support 3D content. The content can be accessed through the *Layar* app. The company charges a monthly fee per project.

Augment, founded in 2011, defines itself as an augmented reality platform for product visualization. It allows assigning custom 3D objects to printed targets, but not many options for customization. Basic experiences can be created directly through the browser, while *Augment Desktop* offers more possibilities. There is a monthly subscription assigned per project. The experiences are store in the cloud and may be accessed through the Augment app.

WakingApp AR Creator, formerly known as *EnTiTi Creator,* was launched by *WakingApp* in 2013, offered easy AR experience creation by a custom app. It allows interaction created with node-based system. It offered free content creation, but in 2018, during the change of name and software update, adopted the monthly subscription system. The experiences can be viewed using the company's app or by embedding them in other apps.

ZapWorks, launched in 2016 by Zappar, offers both *ZapWorks Designer*, a drag-and-drop creator for simple experiences, and *ZapWorks Studio*, which offers more room for customization through custom scripts. It *"features 3D support, scripting language, time-lining, 360-degree photo spheres and a host of other features out-of-the-box"* (Zappar, 2016). It also offers a monthly subscription. *ZapWorks* provides two options for accessing the experiences, either by using their app or by embedding the experience in an existing app.

Artivive, launched in 2018 allows embedding 2D video and GIF animations to physical supports. With *Artivive Bridge*, launched in 2019, it is possible to change these objects' position and rotation in 3D space, but there is no option to import 3D models. It has been used in several graphic design projects and exhibitions.

1.5.2. Custom apps and Software Development Kits (SDKs)

In some cases it may be advantageous to develop custom applications, such as situations where the content is more complex regarding interaction and functionality that would not be supported by the SaaS platforms or, for instance, if one wants to customize the app design or include a brand, product or project logo - it provides control over the whole process. However, if we are working with only a couple experiences, it might not justify the time and monetary investment to develop and publish a custom app.

There are plenty of resources available to aid the process. Several companies offer Software Development Kits (SDK) that allow building AR apps without the need to develop everything from scratch. An SDK is a set of software development tools which allow creating applications for a certain development platform (Sandoval, 2016). In the case of AR, the software development kits provide all core functionality required to create basic AR experiences, allowing customization, with the main limitation being one's development capabilities.

These kits can be implemented in applications through tools such as *Android Studio* (*Android* native development), *Xcode* (*iOS* native development), and *Unity*, a game engine used to develop 2D and 3D games for several platforms. *Unity* may also be used to create non-game apps that make use of tools for game development, as is the case with some augmented reality apps. Moreover, there are many online courses and tutorials focusing on *Unity* and the engine's online community board is highly active allowing to find solutions for known issues or asking for support whenever necessary. I will now briefly introduce the SDKs that were tested during the practical process, as well as some released later but considered relevant to the project.

Vuforia was released by *Qualcomm* in 2011 under the name *QCAR* and was bought in 2015 by *PTC*. *Vuforia* is cross-platform and has not only a very active online community but also plenty of resources to learn from. It has direct integration with *Unity*, allowing for faster and easier AR development aided by extensive documentation.

MAXSTAR, an SDK from the company *MAXST* was still in early development stages when discovered during the research and hadn't matured enough for the project's needs. Several versions have been released since then, adding a wide range of new features to the SDK.

Both *Vuforia* and *MAXSTAR* provide free licensing – with watermarks and limited app usage – and pro licensing. Other software development kits like *Wikitude* and *Kudan* were considered but later discarded due to high licensing costs.

ARKit, released by *Apple* in June 2017, allows AR app development for *iOS* devices. *ARKit* requires *iOS 11* or later. Version 1.0 did not support 2D target images, but that features was implemented later with the release of *ARKit 1.5*. Version 2.0 was released in September 2018, being compatible only with *iOS 12* or above, while adding several new features like multi-device experiences between different users and improving the ones already available such as tracking quality.

ARCore, released by *Google* in March 2018, allows AR app development for *Android* devices. Like *ARKit*, it is still limiting in terms of software compatibility, being exclusive to *Android 7.0* (*Nougat*) or later due to advanced features such as light estimation, which adjusts the virtual content color to match the real world lighting for an increased sense of realism. Both *ARKit* and *ARCore* are free, at the cost of lacking cross-platform compatibility.

AR Foundation, released by *Unity* in 2018, is a handheld (mobile) AR ecosystem, which is capable of combining *ARKit* and *ARCore* for cross-platform apps, which circumvents the limitations pointed out before. During the process execution there was no support for image targets. It was implemented later but didn't prove to be robust enough to provide the same quality as the one obtained using *Vuforia*.

During our research, we found a comparison table (Fig. 9) at the *ThinkMobiles* website, which includes, among others, the SDKs mentioned above.

	Wikitude	**ARKit**	**ARCore**	**Vuforia**	**MaxST**	DeepAR	EasyAR	*ARToolKit*	Xzimg
Maximum distance capture (m)	2.4/5	**1.5 / 5**	**1.0 / 3**	**1.2 / 3.7**	**0.5 / 0.9**	0.7 / 5	0.9 / 2.7	**3 / 3**	0.5 / 1
Recognition stability of immovable marker	6	**9**	**9**	**10**	**7**	8	7	**8**	4
Recognition stability of movable marker	6	**7**	**6**	**6**	**2**	7	3	**6**	3
Minimum angle recognition	10	**30**	**50**	**30**	**50**	35	35	**10**	45
Minimum visibility for recognition (overlap)	100%	**50%**	**75%**	**20%**	**50%**	10%	10%	**100%**	25%
2D Recognition	●	●	●	●	●	●	●	●	●
3D Recognition	●	●	●	●	–	–	–	–	●
Geo-Location	●	●	●	–	–	–	–	–	–
Cloud Recognition	●	●	●	●	–	–	–	–	–
Slam	●	●	●	●	–	–	–	–	–

Fig. 9 – SDK Feature Comparison Table. Adapted from ThinkMobiles (2018).
Retrieved January 2019, 2019 from *https://thinkmobiles.com/blog/mobile-game-development-tools/*

If the data presented is correct, *Vuforia* could be considered the optimal SDK for the project's needs: it has the highest maximum distance capture, Recognition stability and highest tolerance regarding minimum visibility for recognition (overlapped markers). From the tests performed during early stages of app development – between *Vuforia*, *MAXST* and *ARToolKit* – the tracking algorithm offered by *Vuforia* certainly proved to be the most stable under most lighting conditions. *ARCore* and *ARKit* were still under early development so they were not tested.

1.5.3. Considerations

These tools and services are continuously updated, and at the time of writing this report much has changed since the beginning of the project (early 2017). Some tools now offer embedding services, allowing the use their platform for creation and further implementation on another application, which wasn't possible before.

For instance, *WakingApp AR Creator*, formerly known as *EnTiTi*, was considered as a possible tool to develop the final project. It was free and easy to use despite some of its limitations. Eventually we opted for a custom app and, several months later, the company announced that an updated platform with a monthly subscription model, which would have not been viable for the project.

Vuforia was chosen because it worked cross-platform and there was plenty online content to learn from. *ARKit* and *ARCore* were announced later, but were at the time limited to either *iOS* or *Android* (*ARCore* now supports cross-platform, but *ARKit* remains *iOS* only). *AR Foundation* by *Unity* offers a solution to work with both at the same time without having to prepare two apps simultaneously, however the tracking system has limitations that were considered unviable as an alternative.

2. EXISTING PROJECTS

2.1. THE MOVING POSTER

The Moving Poster is a project by Josh Schaub consisting of an inventory of animated posters that aims to explore the boundaries of this increasingly common medium. *'Where does the poster end and where does a film begin?'* is one of the questions raised by Schaub at the project's website. *Moving Poster #2* consisted in an exhibition featuring these animated posters, viewable through an Augmented Reality mobile app (*Artivive*) that superimposed 2D animated videos over the printed images. This second issue of exhibition series was present at the *Weltformat Festival*'s 2017 edition (Fig. 10).

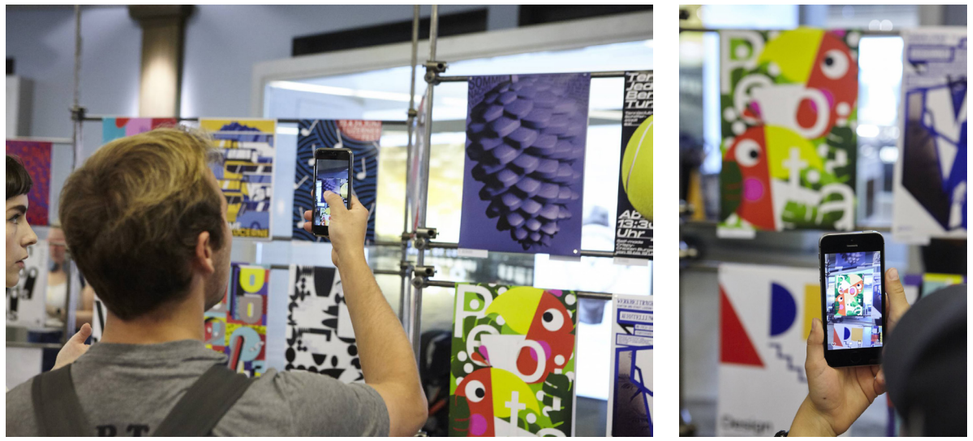


Fig. 10 – *Moving Poster* edition two at *Weltformat Festival 2017*. Photos by Savino Caruso and Marco Sieber.
Retrieved September 20, 2018 from *https://weltformat-festival.ch/en/2017/exhibitions/das-bewegte-plakat-2*

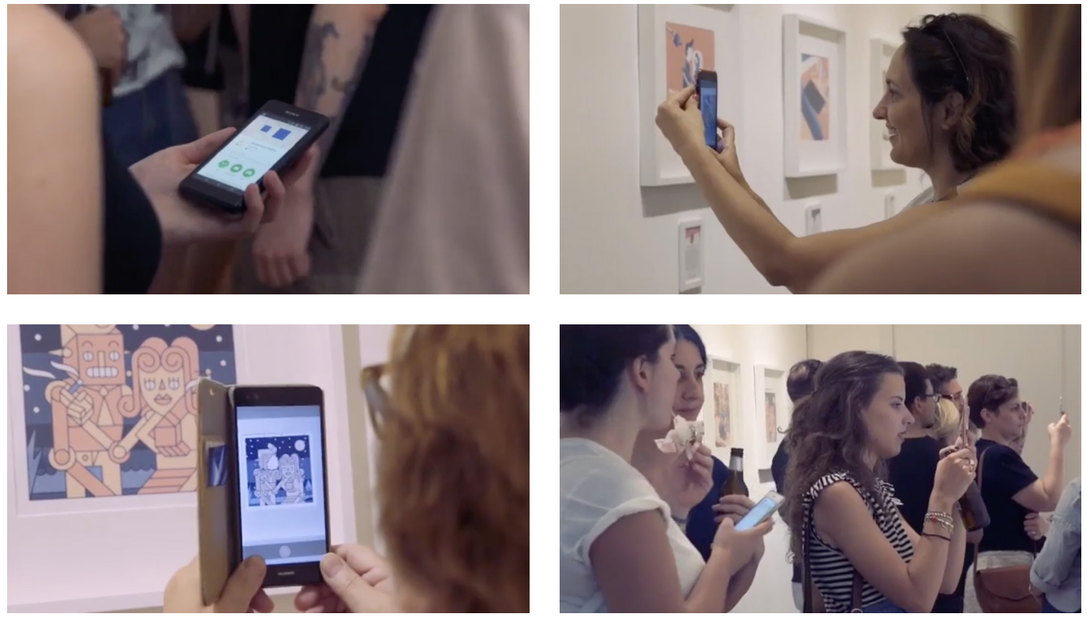
In the *AIGA Eye On Design* blog post *Poster Design is on the Move. But Where is it Going?* by Madeleine Morley (2018), the author claims that the term Moving Poster *"was coined by Swiss designer Felix Pfaelli a few years ago"*. It is also concluded that in order to be considered a moving poster, it *"must retain the formal elements of a poster, communicate using traditional rhetoric, scale to fit the portrait format, and employ animation as if it were a "fifth color" or a special print technique."*

By using the AR medium, the poster can come to life without the need of a dedicated digital screen, such as the ones used in the first edition of *Moving Poster* (Fig. 11). Even though the use of AR in this project adds a new layer to the poster, it doesn't take advantage of the 3D possibilities due to the platform's limitations.

Fig. 11 – Moving Poster edition one, using digital screens to display the animated posters.
Retrieved September 20, 2018 from *http://joshschaub.ch/*

2.2. ALCHEMICA GALLERY

Alchemica Gallery is the name of the project and exhibition (Fig. 12) by *Alkanoids*, a design studio based in Milan, Italy.



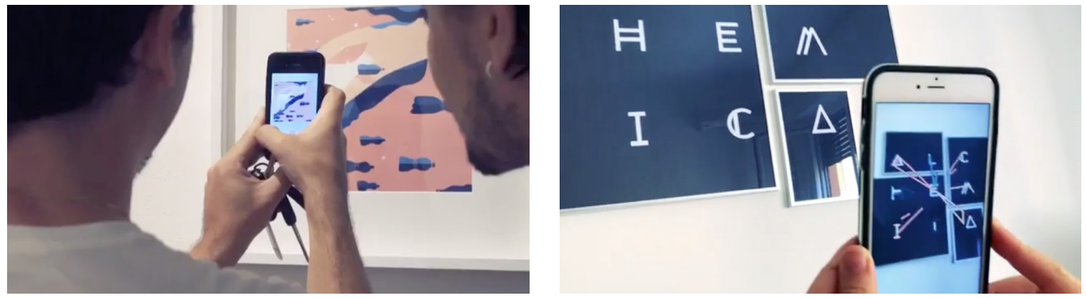


Fig. 12 – Frames from the *Alchemica Gallery* exhibition video.
Retrieved September 20, 2018 from *https://vimeo.com/255788325*

The artworks can be seen with AR using the *Aria* (formerly known as *Alchemica Gallery*) mobile cross-platform app developed by the studio. Just like the *Moving Poster* AR exhibition, it overlays 2D videos with sound over the illustrations but it is made using a custom application that has the project's identity reflected on its design. Several artists and animators were invited to create a series of animated artworks.

2.3. DIA STUDIO AND ZACHARY LIEBERMAN

DIA Studio is a NY based design agency specializing in kinetic identity systems. They have worked together with Zachary Lieberman, an artist and researcher dedicated to exploring new modes of expression. Lieberman is a teacher at the *School for Poetic Computation* (NY) and is one of the co-founders of *OpenFrameworks*, a c++ library for creative coding. The collaboration between *DIA Studio* and Zachary resulted in a series of experiments where typography was placed in the real world (**Fig. 13**) using spatial AR, where there is no specific image target to attach the AR content to. Due to their online exposure, these experiments brought AR to the table for many designers, which started creating similar experiences. Most of these derivations are simulating AR by inserting the digital content through post-production on pre-recorded videos. Since this method does not happen in real time it can't, by definition, be considered true augmented reality.

Fig. 13 – Typographic experiments using augmented reality.
Retrieved September 22, 2018 from *https://www.instagram.com/dia_studio*

Zach Lieberman and his partner Molmol Kuo released *Weird Type* app for *iOS*, which allows the user to freely place typography in 3D space, using different shapes and animation presets. (**Fig. 14**)

Fig. 14 – *Weird Type* screen captures/previews.
Retrieved September 22, 2019 from *https://apps.apple.com/us/app/weird-type/id1352785248*

The app release was shortly followed by the '*Zach Lieberman's New App Turns Type into a 3D Object*' blog post by Liz Stinson (2018) at *AIGA Eye On Design*, which describes it as "*Colors, shapes, and typography behave impossibly; they bend, twist, and burst apart in midair like they're physical objects.*" It was also found in the blog post that the app was developed using a combination *ARKit* and *OpenFrameworks*, "*the coding language Lieberman developed to create new media art*".

The aim of the app was to make augmented reality more accessible to the average person, without requiring the technical know-how that is needed to create these projects. The author also claims that Lieberman suspects it will become normal to think of type as an object that is not only on your screen but also in the physical surrounding us. This app also brought AR creation to many designers, allowing them to draw their own experiences even though they were limited to the designers presets, with an option to use custom words or sentences. To work with content like this we should think in 3D, as Lieberman affirms, and this application can be a great starting point for a designer to venture into the medium.

2.4. THE EXPOSED MAGAZINE

Counting with two issues, *The Exposed* (Fig. 15) is described as *"a print a magazine that combines offline and online"* at Stack Magazine's blog post *The Exposed issue 2* by Grace Wang (2018).

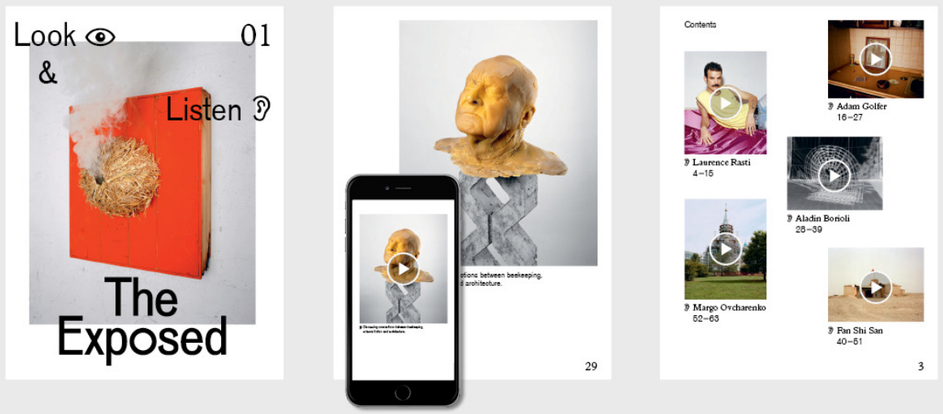


Fig. 15 – *The Exposed magazine Issue 1.*
Retrieved September 22, 2019 from *http://www.the-exposed.com/*

The magazine's AR app (Fig. 17) is used to supplement storytelling through video and audio. If the AR app is absent the magazine works as "standalone work of art" with high quality photography, which means we don't necessarily need to see it with the app but it allows the discovery of a new layer of information.

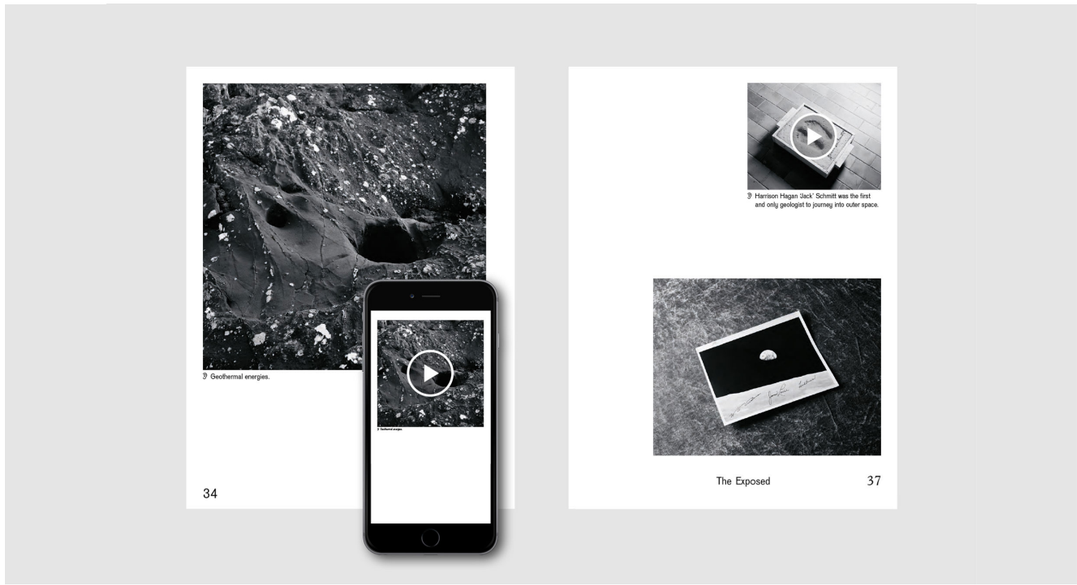


Fig. 16 – *The Exposed magazine Issue 2.*
Retrieved September 22, 2019 from *http://www.the-exposed.com/*

While the printed pages aim to intrigue the reader through strong imagery, the AR app brings up a new editorial context to the table.

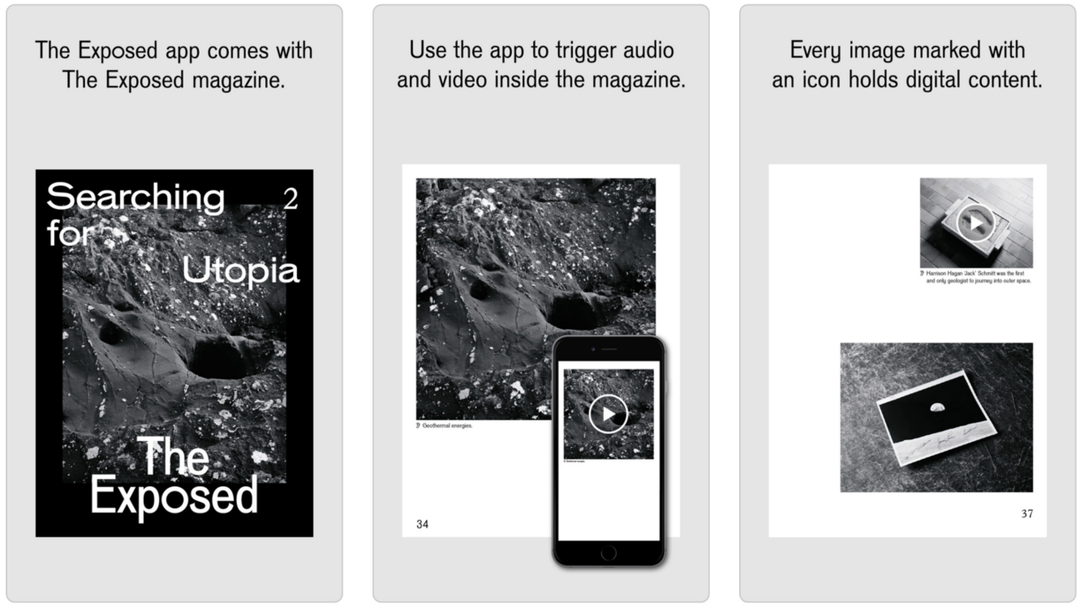


Fig. 17 – *The Exposed* app previews.
Retrieved September 22, 2019 from *https://apps.apple.com/dk/app/the-exposed/id1030752632*

In the same blog post featuring an interview with the magazine's founder and editor-in-chief Henriette Kruse it is mentioned that the biggest challenge is figuring out how to enrich the story with AR, and not how to technically execute it.

3. GRAPHIC AND TECHNICAL CONSIDERATIONS

This chapter introduces the graphic and technical considerations for designing the image targets and content of the project's experiences. It also includes some tips or workarounds to prevent common issues that may arise when designing with augmented reality. Since different software may present different limitations, the software used is *Maxon Cinema 4D* for 3D content creation, and *Unity Engine* for app development using the *Vuforia* augmented reality SDK. However, most of the content is believed to be applicable to other tools.

3.1. DESIGNING IMAGE TARGETS

Image targets do not always perform equally well on different SDKs, since each one uses its own tracking algorithm which might provide different results. However, there are some core aspects to consider while designing AR targets that were learned through trial and error during the project. These limitations will often have an impact the final graphic output.

The AR camera recognizes and tracks image targets through the contrast based natural features being captured through the camera feed. Both the design and printed finishing has an impact on the experience quality. The targets are rated on a scale of 0 to 5 (Fig. 18), represented by dots here. The rating is generated after adding a new image to the database. Images should have at least 1 to 2 points for being minimally stable. Images with 4 to 5 points provide the highest tracking quality and therefore a smoother experience.

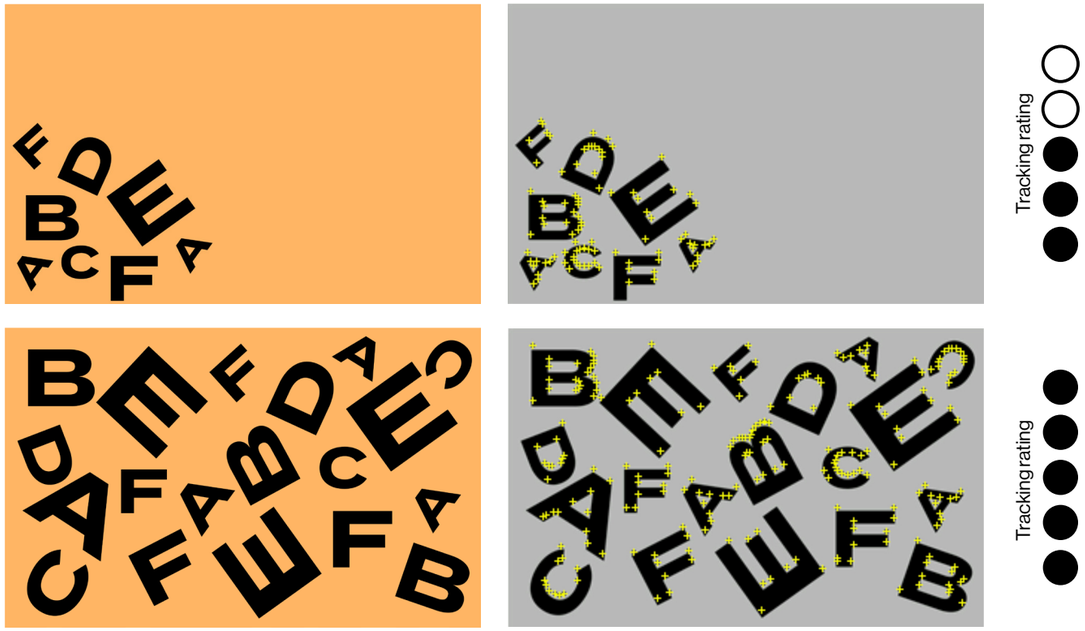


Fig. 18 – *Target rating examples. The image below has more detail distributed among an even area, providing better results.*
Reference point maps and target rating retrieved from Vuforia Target Manager

The target should be rich in detail in order to generate enough interest points. For instance, a white poster with just a small letter or word in the corner would most likely not work as an image target. It is also recommended avoiding repetitive imagery (Fig. 19) such as checkerboard patterns, as they do not provide enough distinctive natural features for the tracking algorithm to work properly, even though they might generate many reference points. This results in poor AR experiences where the virtual content will either keep disappearing or be unable to stabilize its positioning in the 3D space.

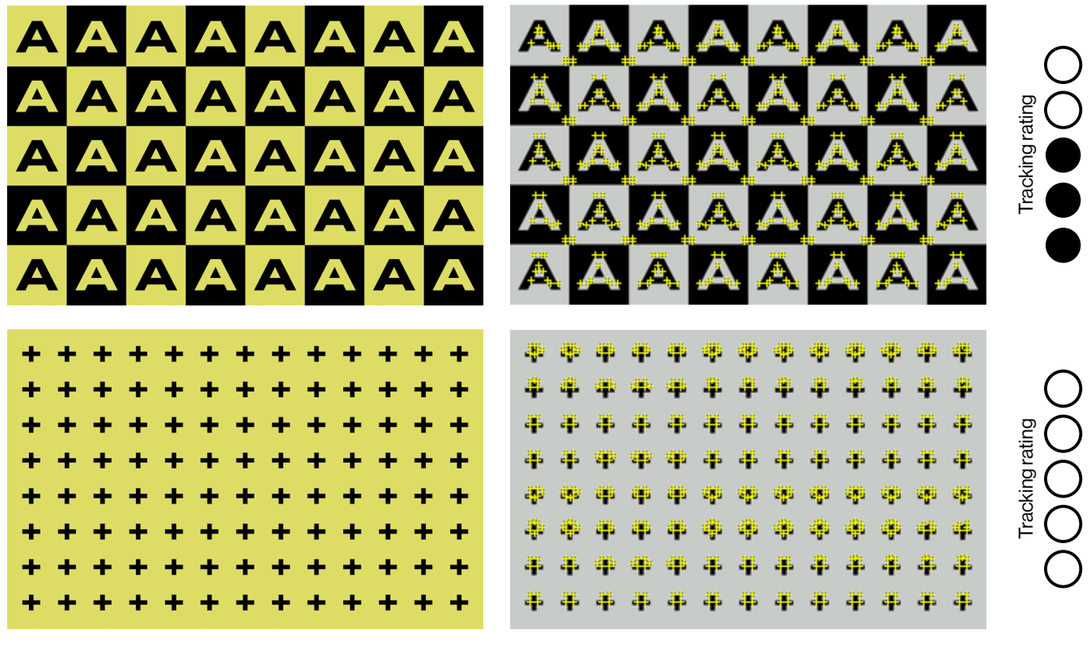


Fig. 19 – Examples of repetitive patterns (left), generated reference points (center) and target rating.
Reference point maps and target rating retrieved from Vuforia Target Manager

It is also important to have enough vertices. Rounded shapes generate less interest points and should be compensated with cornered elements. While a square will generate 4 points of interest, a circle sometimes generates one or, in some cases, none (Fig. 20). This could represent a major limitation in the design process. For instance, an image made up of only circles could perform very poorly as a tracker. This means that the technical limitations have some control over the visual output and overall aesthetic, since they favour images rich in detail.

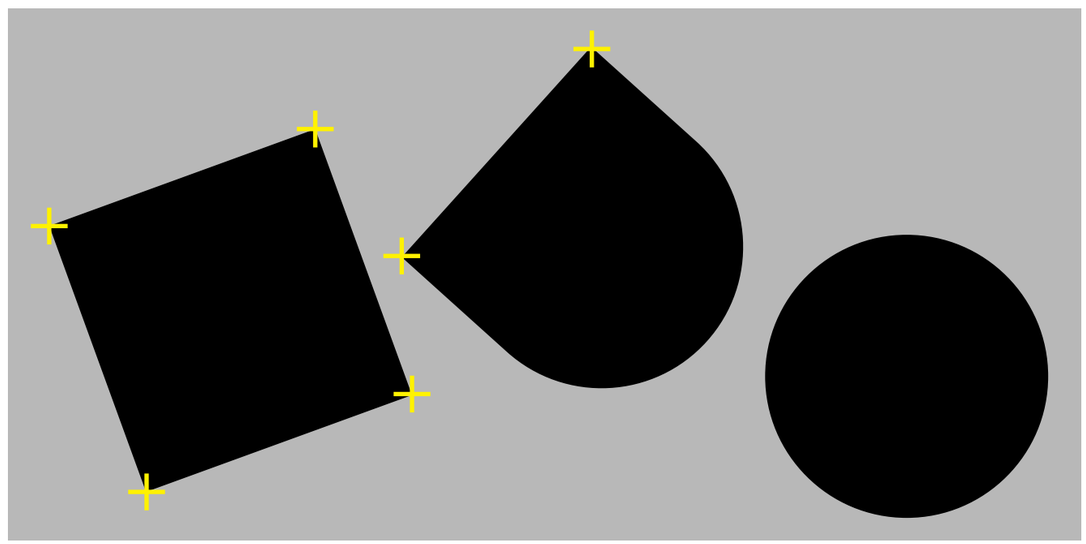


Fig. 20 – Rounded shapes don't provide enough features to generate reference points.
Reference point maps and target rating retrieved from Vuforia Target Manager

Having good contrast is fundamental for optimal tracking quality and helps providing smooth AR experiences even in low light environments. Since the tracking algorithm works in black and white, it provides better results when the image target has contrasting tones (Fig. 21).

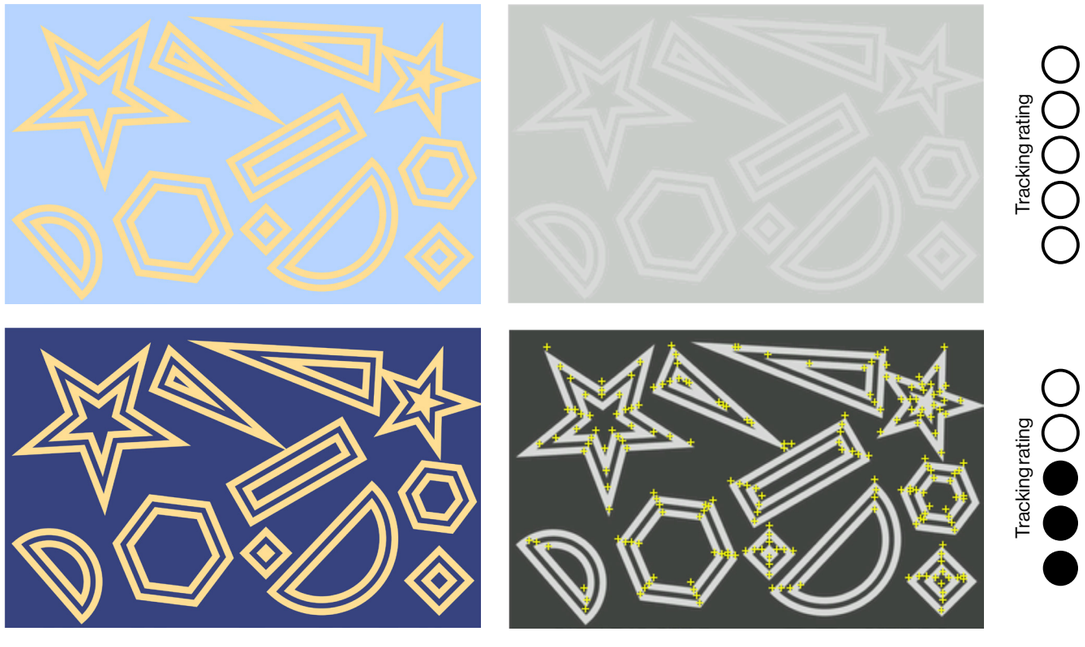


Fig. 21 – Interest points comparison between high and low contrast image target.
Reference point maps retrieved from Vuforia Target Manager

An efficient way to evaluate a grayscale image quality is checking its histogram. Image with average low contrast and narrow histograms are not good targets. If the histogram is wide and flat, it is a good indicator that it could make a good image target, however it does not assure a viable target. For instance, a poster containing a detailed photography will be rich in the histogram information, while a poster with flat colors and typography might not provide such a rich histogram but can still make a good target. The image should always be tested in early stages to guarantee it works as intended. In some situations the target manager returned a 5 point target rating that performed worse than another 3 points target.

Apart from the design considerations, there are other factors that impact tracking quality. Since the tracking relies on what is being captured by the camera, a well-lit environment with diffuse lighting provides better results. Target based AR experiences tend to work better in indoor environments where lighting is more stable and easily controlled. It is also important to consider paper and printing finishes. Glossy finishes (Fig. 22) may decrease overall quality under certain light conditions such as a lamp that creates reflections covering a big portion of the image target.

Fig. 22 – Glossy materials may generate undesired reflections that will occlude part of the image target.
Retrieved June 5, 2019 from *https://library.vuforia.com/*

The printed targets should also be as flat as possible, since bending will highly impact tracking quality. When working with targets that are meant to be handheld, such as postcards, an efficient way to prevent bending is using thicker paper.

Since each printer provides different results, the digital assets were often adjusted after printing the final posters, in order to match the app content's colors with the printed version. This was considered important as it presented a more natural transition into the 3D version of the AR experience.

3.2. 3D CONTENT: DESIGN, ANIMATION AND OPTIMIZATION

When designing the 3D content to be integrated in the AR app, there are some things to keep in mind. As mentioned earlier in Chapter 1.2 (*Real-time rendering*) all rendering calculations are performed in real-time, as such the amount of polygons that make up the 3D object will dictate how fluid the experience is.

During the project, there were always two versions of the same 3D content: one with highly subdivided objects (used to render the image target itself, where additional render time is not relevant), and one with a lower polygon count (to be embedded in the application and perform well on most devices).

All this, of course, depends on the computational power of the viewing device. One of the concerns of the project was to provide fluid experiences to most users, so the 3D scenes were made to be as light as possible, both on the polygon count, lighting and type of materials used. If the AR experiences includes high quality shadows and advanced shaders/materials (Fig. 23) that contain reflections or other computational heavy characteristics, it could limit the viewing quality on older devices. When using image textures on 3D objects, the texture resolution will affect app size and viewing performance. A high resolution image allows zooming in further without visible pixelization but hinders performance. During the development of the project on older *Android* device could not display an 8K image that was used to wrap around an object, and displayed a placeholder color instead. When reduced to 4K, the app performed as intended but the blurriness when viewing up close was more noticeable.

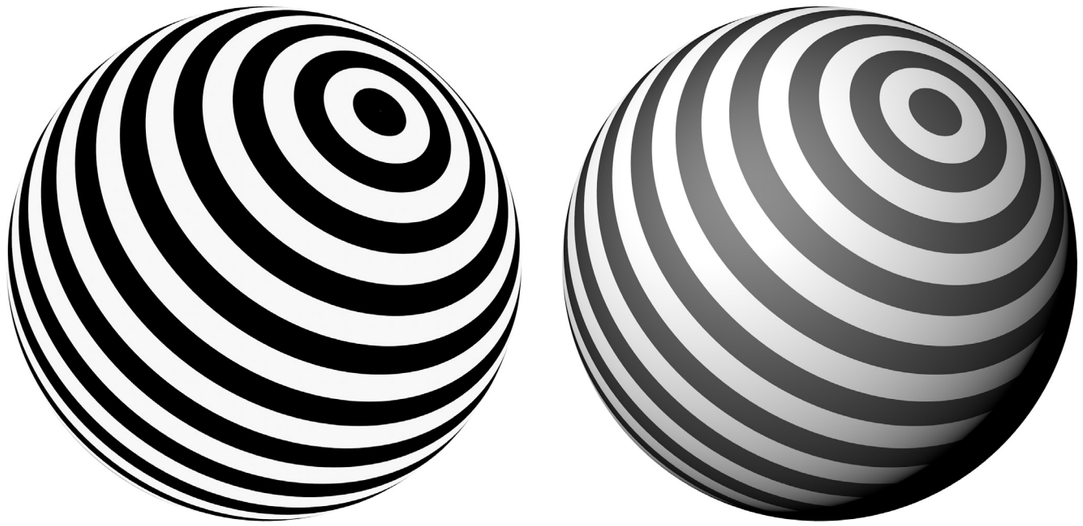


Fig. 23 – 3D object with different shaders. The performance decreases as the materials become more complex and require more calculations to be output – which might slow down experiences (FPS loss) and drain the device's battery.

Animation is another key component of AR. Not only can the content become three dimensional, it can come to life through the use of animations. There are different types of animations that can be used for the 3D content, such as PRS (Positioning/Rotation/Scale) (Fig. 24), which does not directly modify the 3D object mesh, but rather where they are positioned in 3D space, what angle they are rotated on and how big or small they become. This proved to be the most lightweight type of animation since it does not rely on information assigned to individual mesh points of the 3D object but to the object as a whole.

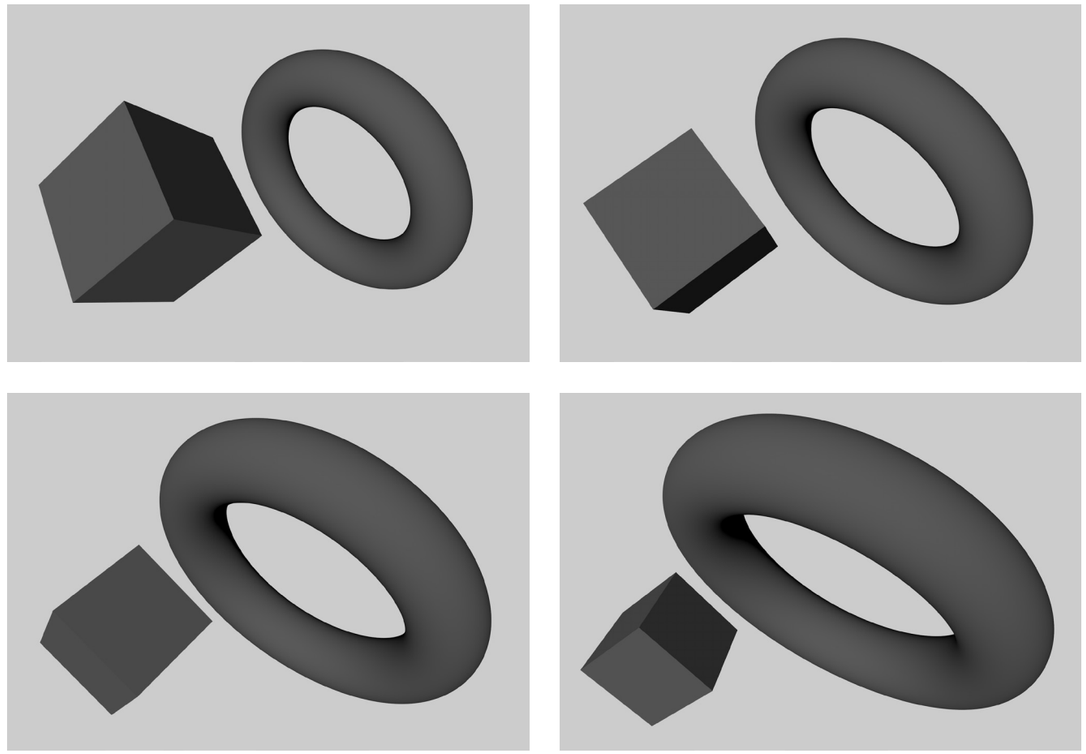


Fig. 24 – PSR animation example frames.

Another way to animate is by using 3D rigging (Fig. 25), which is commonly used to animate human characters or animals, but has many different usages. This type of animation consists in binding the static 3D model to a system of joints and control handles that are later used to pose the character and animate it. This type of animation was not used during the process as it did not suit the generated content's needs.

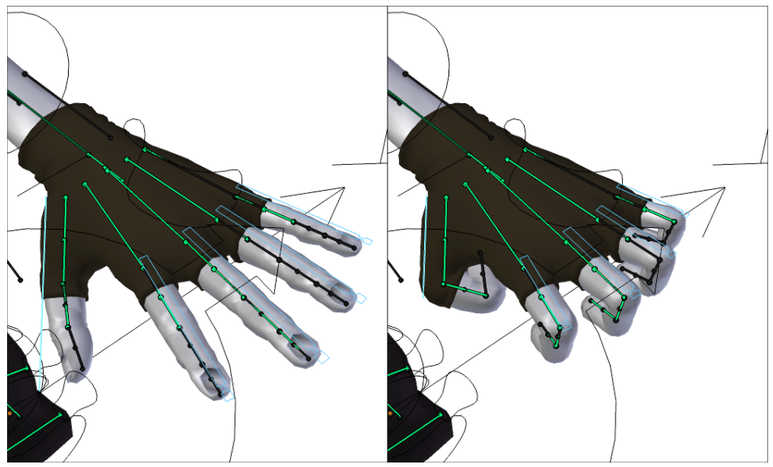


Fig. 25 – Hand rig of the main character in the open source project *Sintel*.
Retrieved June 5, 2019 from *https://commons.wikimedia.org*

The other type of animation is Point-Level Animation (PLA) that works by storing information for each individual mesh point in the 3D object (Fig. 26). It can be used to create more complex animations as long as the polygon count remains the same throughout all frames. The animation information is stored in an individual file alongside 3D object file. We were unable to import PLA animation into *Unity* natively, as it didn't seem to be compatible. At the *Unity Asset Store*, we found an asset that enabled PLA animations importation but it resulted in incompatibilities that prevented the app from even being exported. It was decided that the use of simpler, PSR animations was enough to achieve the desired result, in a compromise between quality and performance.

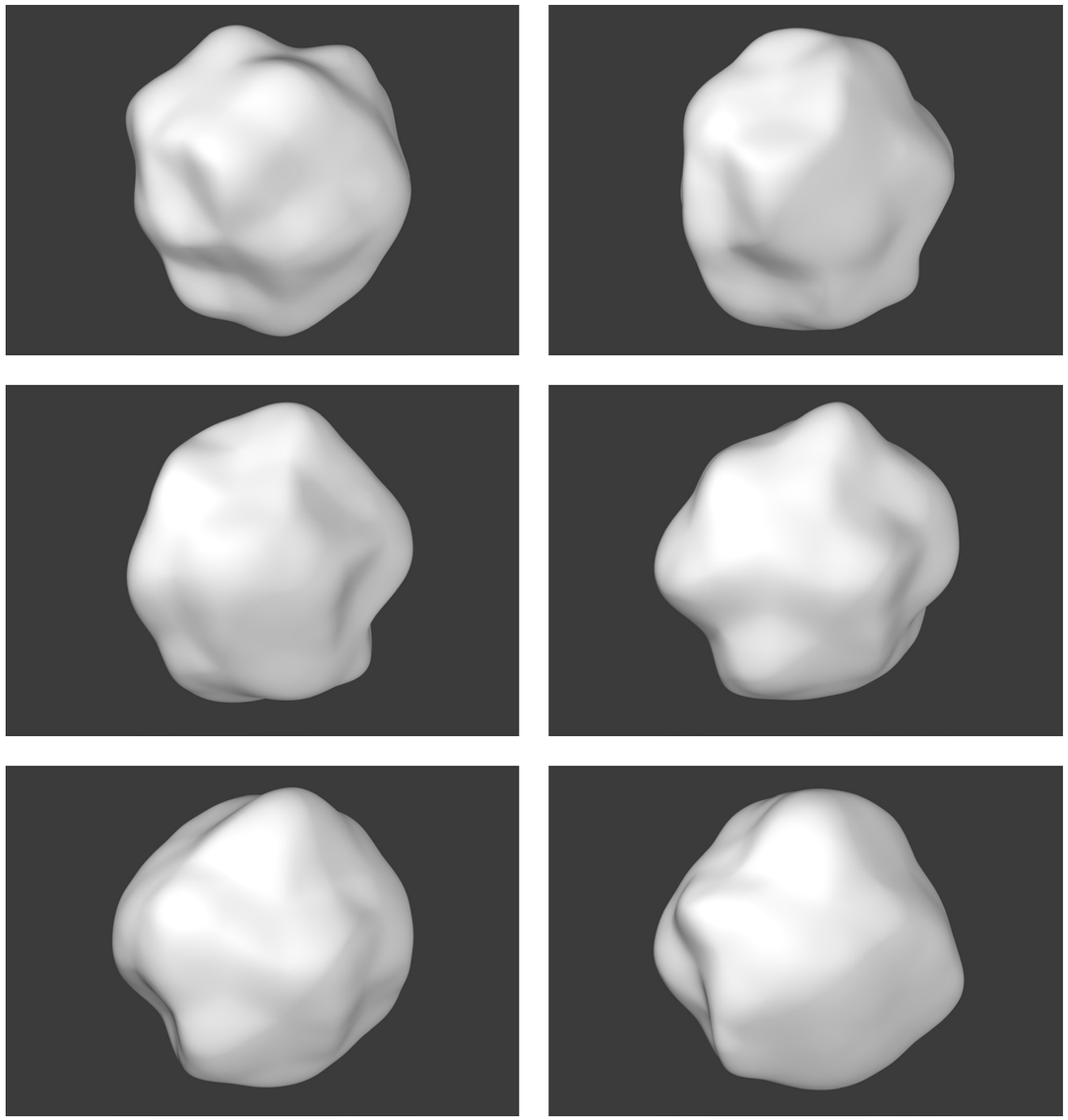


Fig. 26 – PLA Animation example. The sphere polygon vertices are being displaced every frame creating organic deformations. When exported, the PLA information file for the sphere weighted 3.5 MB, which was too heavy in comparison to the rest of the content, considering most posters weighed around 2-4 MB in total. Because all content is stored in the app, keeping the app size low was one of the priorities due to size limitations when publishing the app. To overcome this limitation, it is possible to store content online and retrieve it on app launch or even on target detection, but it wasn't done in this project.

Anti-aliasing (Fig. 27) is a post-processing effect that determines both the visual quality and performance of real-time rendered objects. It is used to smooth edges around 3D objects that are rendered with staircase artifacts due to low screen resolution. However, it may be computational heavy and decrease the frames per second (FPS) of the experience.

Fig. 27 – Anti-aliasing: Disabled (left) and enabled (right). The right image is smoother and looks more natural than the aliased counterpart but is requires more computational resources. Older devices can struggle with these filters if the experience contains a high number of individual elements, so it should be tested during the process across multiple devices.

It is crucial to keep in mind that due to the fast paced technological advances it is only a matter of time until an average or even low-end device is able to run what is considered now complex (or heavy) content with little to no effort. In this project it was considered positive finding a balance between complexity of looks and performance in order to ensure that the app would perform well on a high variety of devices. In *Unity* engine, it is possible to fine tune different quality settings for different devices and operating systems.

4. PROCESS

4.1. PRINTED MEDIUM AND CONTENT

This project started by defining one printed medium to work with. Instead of experimenting different supports it was considered more efficient to restrict it to one in order to easily establish comparisons. The chosen medium was the printed poster since it allowed faster experimentation of different ideas.

Regarding content, the main concern was not creating something inherently conceptual but rather to explore the visual and creative possibilities enabled by the medium featuring simple messages. It was decided that the focus would be the use of typography in 3D space alongside simple, often geometric, shapes. The definition of boundaries allowed more efficiency in the decision making process in the creation of the graphic objects while allowing for coherence and consistency in the project. With the use of augmented reality the poster can have various stages of reading by dividing the message in two parts: the first, printed on the target image; the second, discovered by the user while navigating in 3D around the experience.

The format chosen for the printed posters (Fig. 28) was 36x48.5cm due to convenience while printing on a 1m wide plotter thus allowing printing two at the same time - avoiding waste and reducing costs. This format remained unchanged throughout the whole project. The printed posters served to test, record and document the experiences and were later used in the exhibition. The app colors were adjusted to match these prints if and when there were noticeable differences.

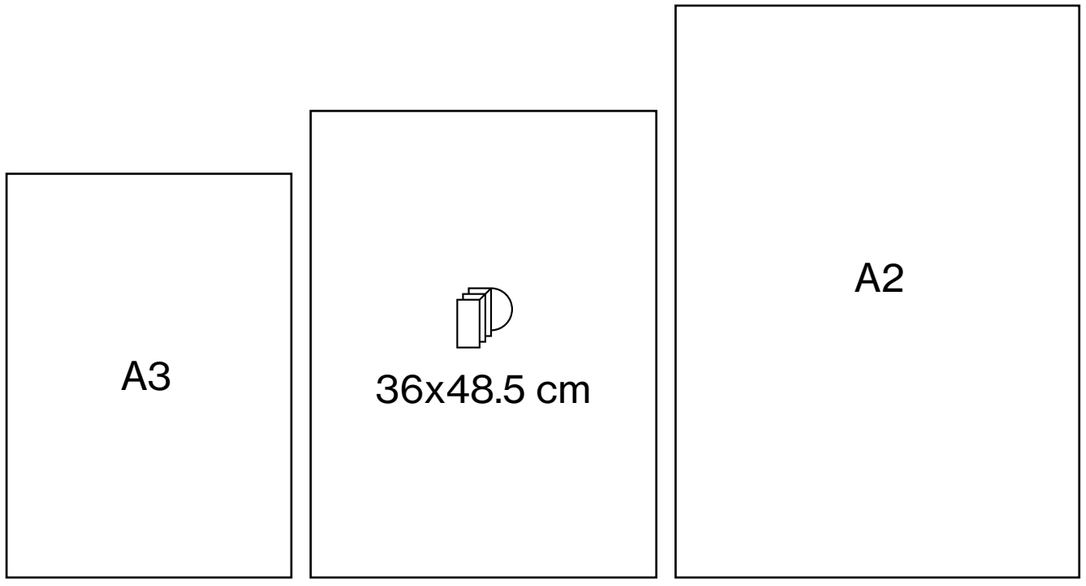


Fig. 28 – Post-print format (36x48.5cm) in comparison with A3 and A2.

4.2. INITIAL TESTS

Upon deciding the medium I started looking for tools to experiment with. The Service as a Service platforms seemed the best option to perform basic testing and four of them were considered. Layar, one of the first AR platforms for content creation available online, was the first to be discarded since it did not support 3D content at the time. Augment was also considered but the fact it was aimed at product visualization limited interactivity, and it required a monthly subscription. Both *ZapWorks* and *EnTiTi Creator* seemed valid fits

for the project. They allowed 3D content and allowed the creation of interactivity either through scripting, in the former or nodes in the later. However, *ZapWorks* only worked with they own markers (named *ZapCodes*) instead of custom image targets implying that the posters needed to have the marker to trigger the experiences. Thus *EnTiTi Creator* seemed the most viable option from the four.

EnTiTi Creator (Fig. 29) was free to use and it allowed easy content creation with a fairly intuitive user interface and node-based system to add interactions with the virtual elements, either by actions triggered upon detection or through virtual buttons. It also allowed embedding sound and MP4 video files.

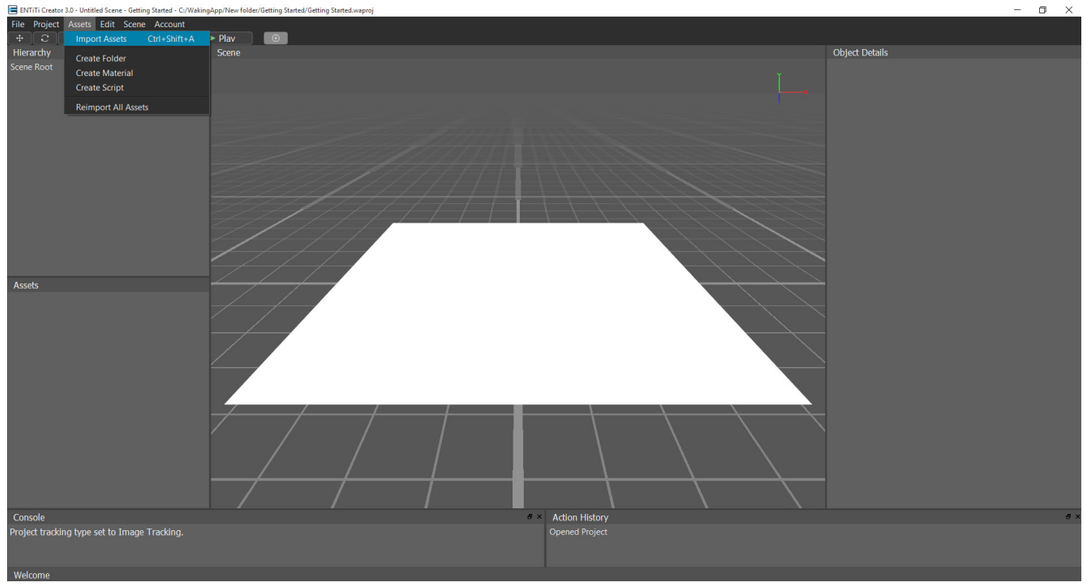


Fig. 29 – *EnTiTi Creator* user interface.

This platform presented some limitations. For instance, in order to view the experiences it required the use of *EnTiTi* mobile app. The app had a very strong brand presence in the user interface (Fig. 30) and it took a long time to visualize the AR content from the app launch.

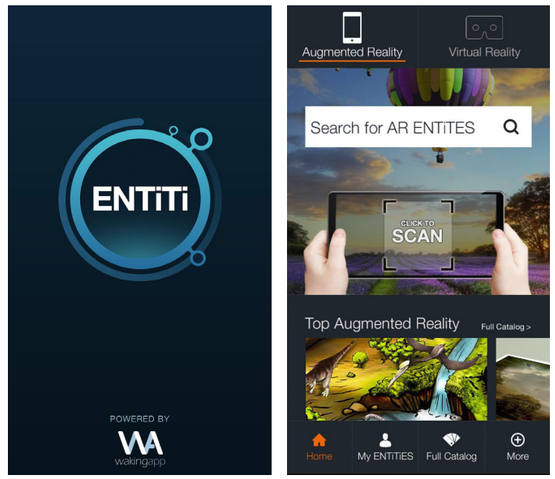


Fig. 30 – EnTiTi player app user interface (Android).

Firstly, the target had to be scanned and detected. The detection was not quick and seemed very unstable working reasonably well sometimes but taking very long in other cases, often providing different results on the same target. Upon detection, the app displayed a button to download the detected experience's content. After finishing the download, the target had to be scanned again and only then would the content be shown.

The tracking quality was not optimal and was quite sensitive to lighting changes. It was considered a good tool to start with but didn't appear viable for the end result. The first test consisted of a very simple target (Fig. 31) with black geometric shapes over white – the high contrast helped detection.

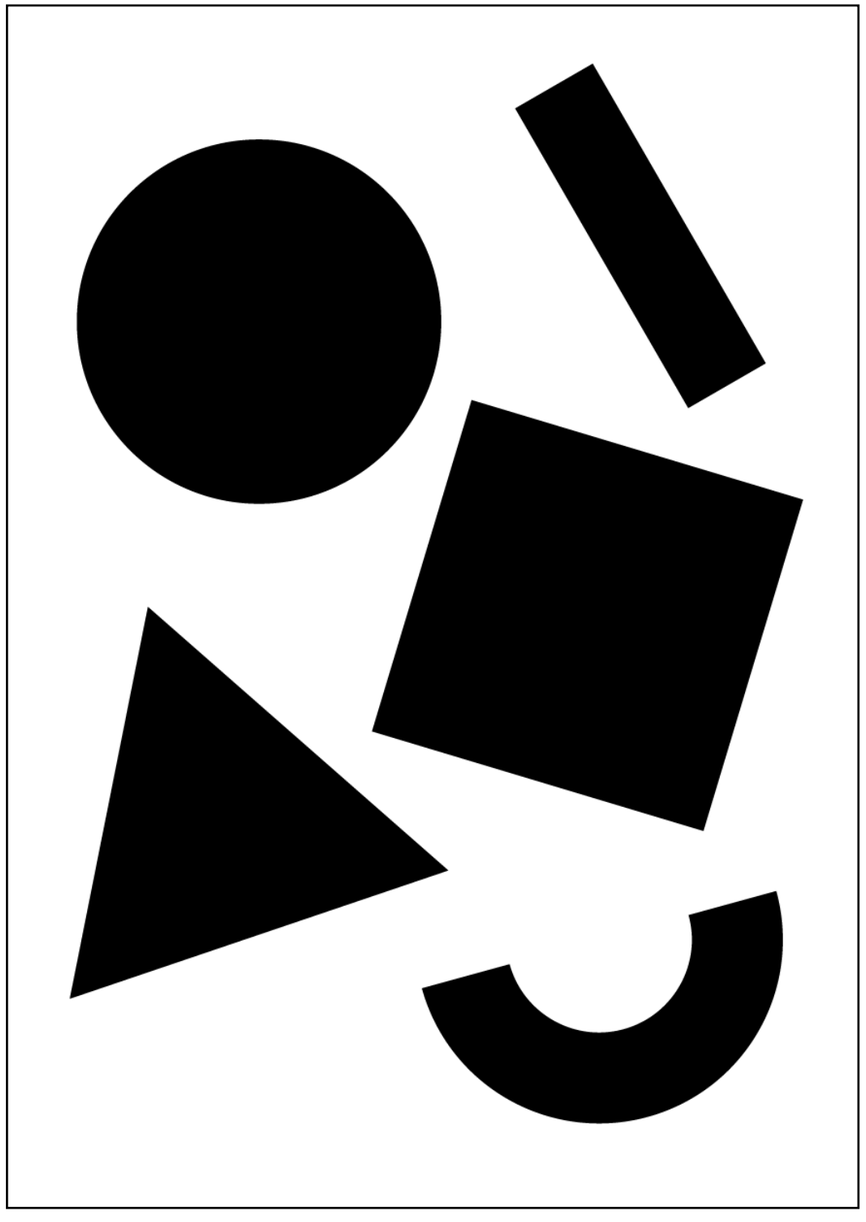


Fig. 31 – First target used in EnTiTi Creator.

The 3D counterpart (Fig. 32) contained the equivalent 3D version of the 2D shapes with a simple color. They were positioned according to the target in the X and Y axis but with different values in the Z axis (depth).

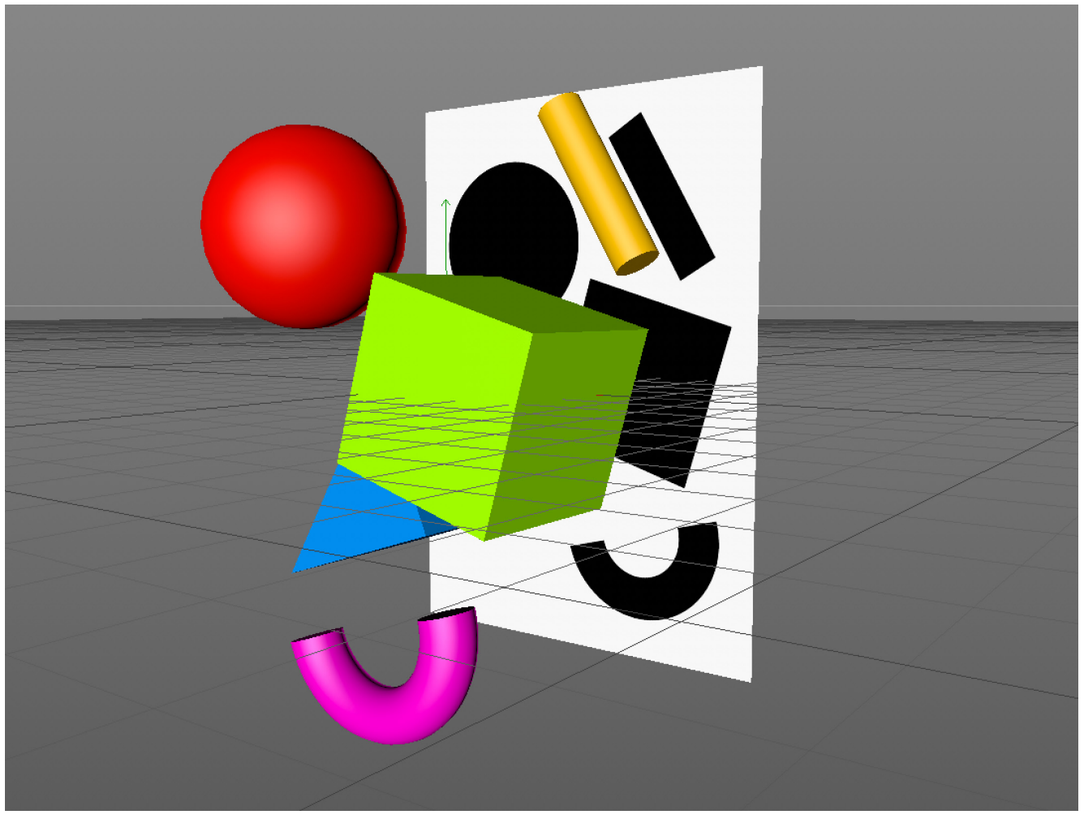


Fig. 32 – 3D version of the content over the target.

After this successful experiment, a second version was created which introduced simple animation (position) on the elements. A third test consisted in a new target that triggered an MP4 video and played a simple sound when tapping one of the elements. There are no records of these tests as on May 8th, the company sent out an email to all users announcing *EnTiTi 3.0*, with several improvements and monthly subscription fee. All existing projects were deleted by then so the access to these project's initial tests were lost and remain undocumented. This version also added support with *ARCore* and *ARKit*, as well as more options towards custom scripting. One of the big changes was that their app was no longer needed to access the content, as it now allowed embedding the content in existing apps (with a viewer SDK), as well as the creation of standalone, white brand apps based on their software.

EnTiTi Creator was discarded before these changes due to the need of their branded app and poor user interface and user experience, allied with unstability in tracking. There were also problems importing custom textures that could not be fixed. It is important to keep in mind that the app was still in beta stages at the time of the initial experiments so problems like these were to be expected.

4.3. TOOLS USED

Upon concluding that *EnTiTi Creator* did not meet the projects needs, and after some research, it was decided to develop a custom app in *Unity* (Fig. 33), using *Vuforia SDK*. Before deciding on *Vuforia SDK*, *MAXST* and *ARToolKit* were also considered but the tracking quality was lower so they were discarded.

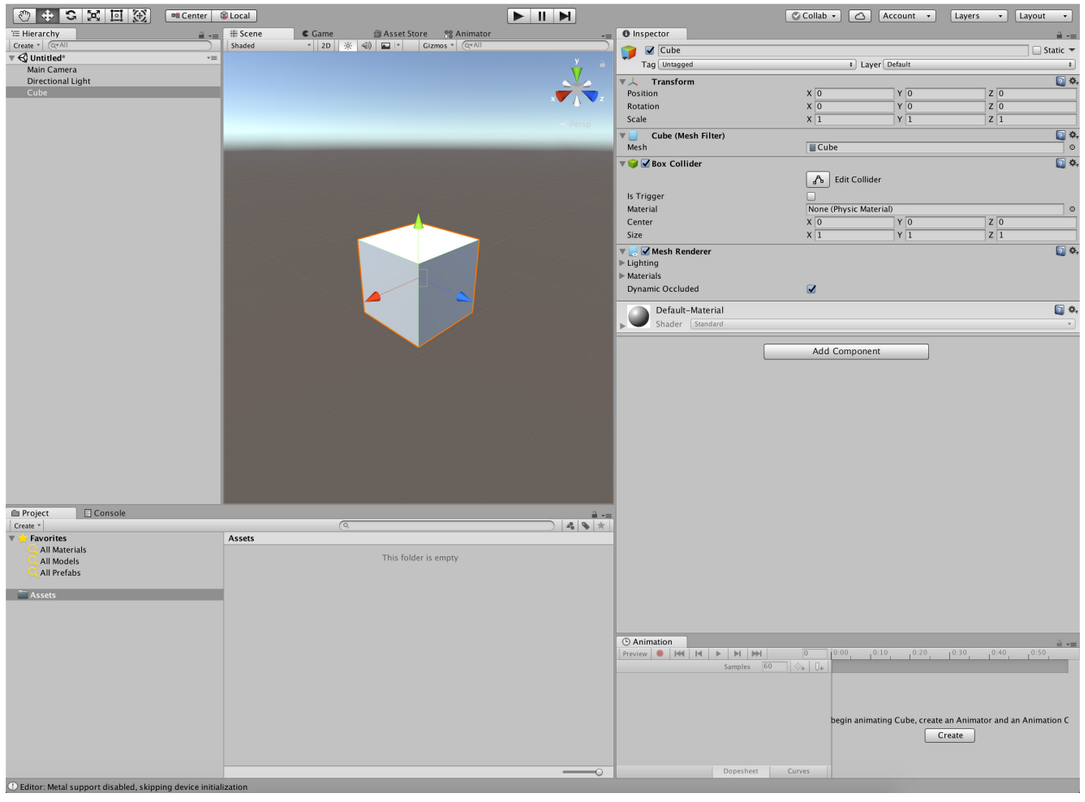


Fig. 33 – Unity user interface.

The integration with *Unity* was fairly intuitive and there was enough documentation to get started. The initial prototype featured no UI using only the AR camera feed to trigger the experiences. This was not a straightforward process and it involved a long and intensive trial and error due to lack of previous experience. The online communities and resources were fundamental to overcome all difficulties encountered in this stage.

Cinema 4D remained the tool of choice for content creation and animation throughout the whole project. *Adobe Illustrator* was used both to design targets and to create the image textures to apply on the 3D objects. *Adobe Muse* was used to design a very simple, responsive website.

4.4. PROJECT NAME AND VISUAL IDENTITY

With the aim of promoting the project and future exhibition a simple identity was designed. The identity consists of a symbol (Fig. 34) that is both a P and a representation of the project's three layers: the printed target and the mobile device, including a third layer in between them that represents the augmented/virtual content.

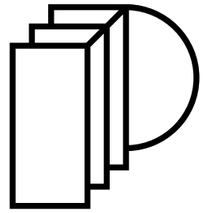


Fig. 34 – Post-print symbol.

This symbol was meant to be used as the app icon and to be included on all the posters for increased recognizability. Besides the symbol, a wordmark featuring the project's name was also defined (Fig. 35).

POST–PRINT

Fig. 35 – Post-print wordmark.

Since the focus was the content itself and not the project identity, it was thought to be fairly neutral and not too intrusive. It uses one color: black and a tint. Typefaces used include the wide sans-serif *Termina* (Fig. 36), designed by Mattox Shuler and published by *Fort Foundry*, used in the wordmark and for display purposes, titles and headlines.

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
01234567890?!@

Fig. 36 – Termina by Fort Foundry.

The secondary, more neutral typeface, used on body text and smaller sizes is *Neue Haas Grotesk* (Fig. 37), designed by Christian Schwartz and published by *Linotype*. Both typefaces are available and were obtained through *Adobe TypeKit*.

ABCDEFGHIJKLMNOPQRSTUVWXYZ
abcdefghijklmnopqrstuvwxyz
01234567890?!@

Fig. 37 – Neue Haas Grotesk by Christian Schwartz (Linotype).

4.5. MEANS OF DISSEMINATION: WEBSITE AND INSTAGRAM

The website was designed and developed using Adobe Muse (Fig. 38). This tool proved to be enough given the simple goal of the website: to have a more detailed text explanation with images and short animations that would quickly inform a new user of the project's purpose and ambitions.

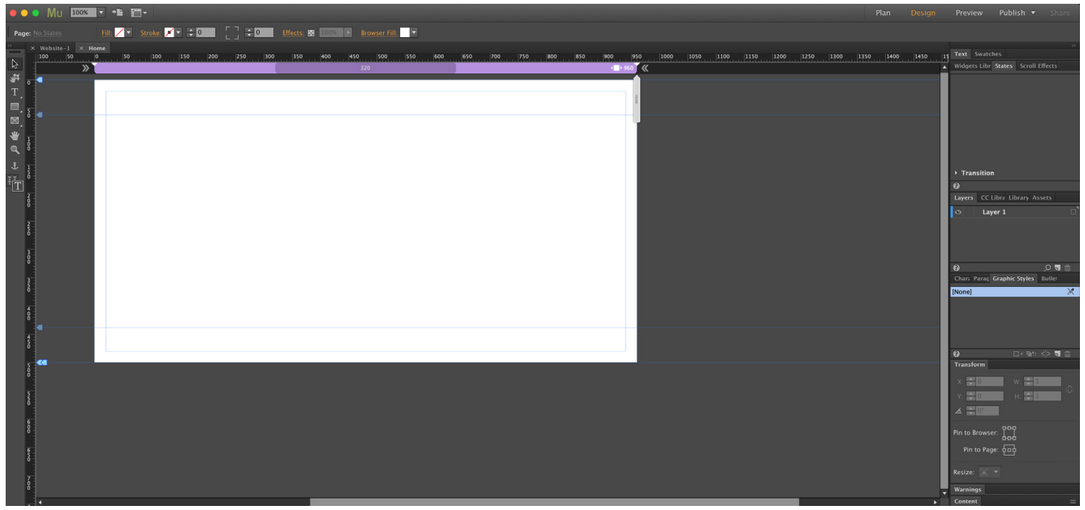


Fig. 38 – Adobe Muse user interface.

Adobe Muse allowed a fast creation of a responsive website (Fig. 39) that worked as intended on a wide range of devices. It also contained links to an email address and to the project's *Instagram* profile.

Fig. 39 – Post-print website (*post-print.com*) across different devices.

Instagram was considered the optimal platform to share the progress. It allowed people to find the project through related hashtags and it was fundamental for finding collaborations that will be mentioned in chapter 5. It was also a way to avoid endless changes in the posters. The decision was made to not go back and edit any poster once it was published. Additionally it made me commit to regular posting, instead of spending unreasonable amounts of time in the same poster.

4.6. TYPEFACE CONTRIBUTIONS

Typography was a key element in the posters and AR experiences. After some research, several emails were sent to designers and foundries requesting typefaces for non-commercial use in the context of the projects. Few emails were left unanswered and most of them had a positive outcome. The project counted with the following typeface contributions: Integral (Fig. 40) by Connary Fagen; Adieu (Fig. 41) by Good Type Foundry; Monitor Display (Fig. 42) by Diana Ferreira; Arre (Fig. 43) by Gonçalo Fialho; SM Häuser (Fig. 44) by Mark Niemeijer; Morion (Fig. 45) by David Einwaller (The Designer's Foundry); Digestive (Fig. 46) by Jérémy Landes; Grandmaster (Fig. 47) by Lucas Descroix (The Designer's Foundry); Favorit (Fig. 48) and Prophet (Fig. 49) by Dinamo Typefaces; lastly, Faktura (Fig. 50) by Futur Neue.

INTEGRAL

Fig. 40 – *Integral* by Connary Fagen.

Adieu

Fig. 41 – *Adieu* by Good Type Foundry.

Monitor Display

Fig. 42 – *Monitor Display* by Diana Ferreira.

Arre

Fig. 43 – *Arre* by Gonçalo Fialho.

SM Hauser

Fig. 44 – *SM Häuser* by Mark Niemeijer.

MORION

Fig. 45 – *Morion* by David Einwaller.

Digestive

Fig. 46 – *Digestive* by Jérémy Landes.

GRNDMASTER

Fig. 47 – *Grandmaster* by Lucas Descroix.

Favorit

Fig. 48 – *Favorit* by Dinamo Typefaces.

Prophet

Fig. 49 – *Prophet* by Dinamo Typefaces.

Faktura

Fig. 50 – *Faktura* by Futur Neue.

The typefaces were provided under the condition that they would be credited when posting on social media and by adding a mention in the website. This resulted in mutual sharing which brought a considerable amount of unexpected exposure to the project's instagram page.

4.7. FINAL POSTERS

This section presents the fifteen final posters and additional information to each of them. They were the result of an iterative process that would be too long to mention here, however they were created according to the considerations discussed in Chapter 3 (Graphic and technical considerations). The posters are accompanied by a short description pointing out the main difficulties and limitations in the design process, as well as alternate versions of the target that did not provide stable tracking. For the sake of conciseness, it is an overview of the final result and will not explain how they were made step-by-step, but will include relevant information in each one.

The animations are all PSR (Position/Scale/Rotation) and imported from Cinema 4D. Texture scrolling on certain objects, present in several posters, was achieved through a custom script written in C# (C Sharp) that was only made possible by merging information found in several posts in the generous *Unity* forum community.

Design decisions were made taking into account performance across a high number of devices, aiming to provide a smooth experience for as most users as possible. As such, shadows and special shaders or materials were avoided. Most of the objects use Unlit shaders that do not receive information from the scene's light, meaning their color remains unchanged, which may sometimes give the illusion of a mix between flat and three dimensional. The posters feature bold use of typography and simple shapes, using contrasting colors in order to guarantee stable tracking performance and fast detection. As mentioned earlier, they all share the same format (36x48.5 cm) and include the Post-print symbol.

POSTER #01
SUBSTANCE/EMPTINESS

We become aware of the void as we fill it.

Despite being one of the simpler experiences, poster #01 took the longest to complete. It represents the first finished AR experience inside the *Post-print* app and it took a considerable amount of trial and error to work as intended. It taught us how to import animated 3D content from *Cinema 4D* into *Unity*, as well as how to achieve the hole/depth effect through masking. It also includes a custom C# script that animated the textures position in the Y axis, something that could not be imported from Cinema 4D. Both the depth mask technique and UV texture scrolling script were throughout the different posters.

The printed version features a spiral shaped ribbon with *'Substance'* and *'Emptiness'* on each side. After scanned, it reveals additional information inside the poster, on the top, bottom, left and right sides.

Fig. 51 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	969 KB
Polygon count	40510
Image textures	2
Images size	350 KB

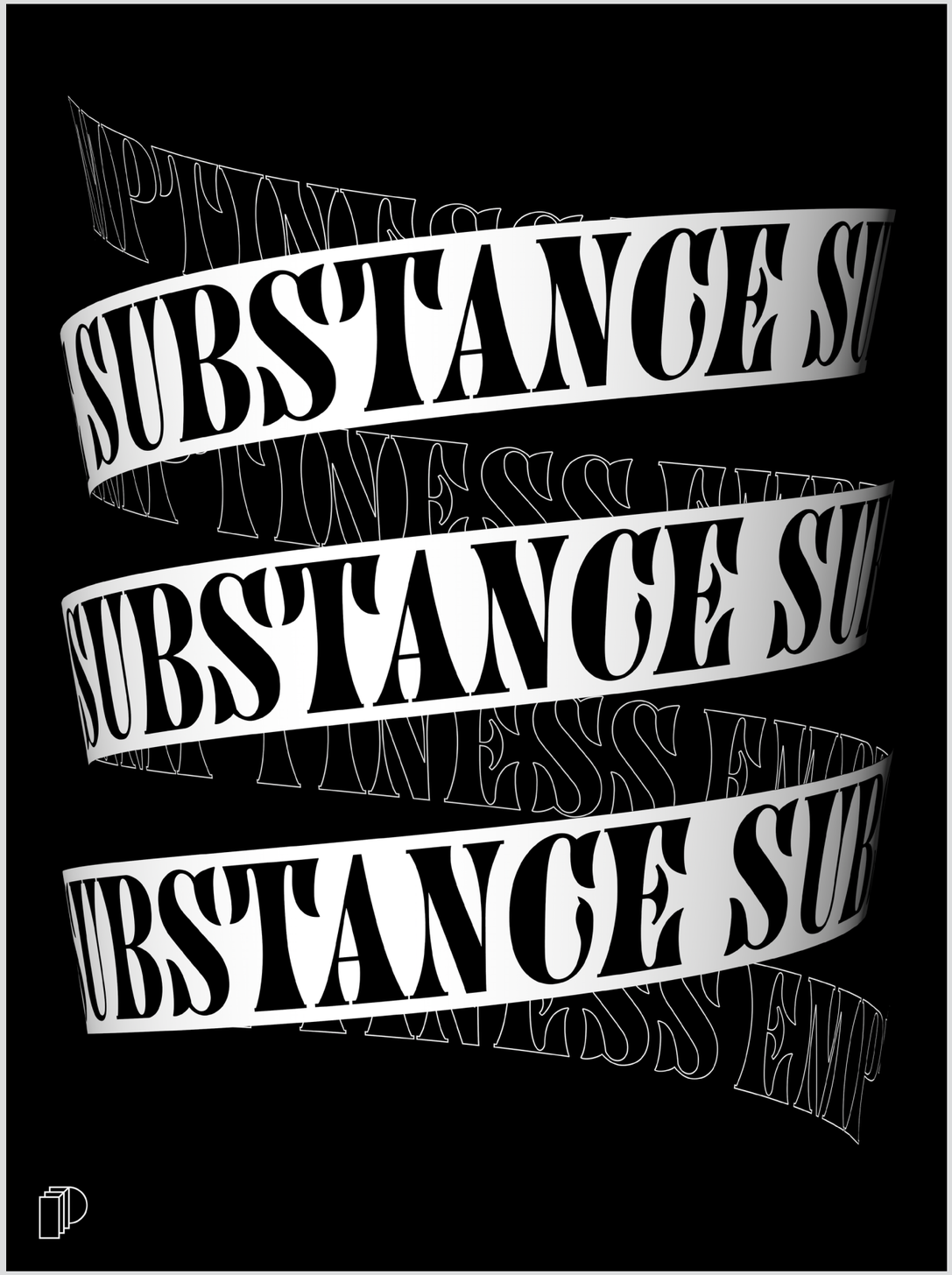
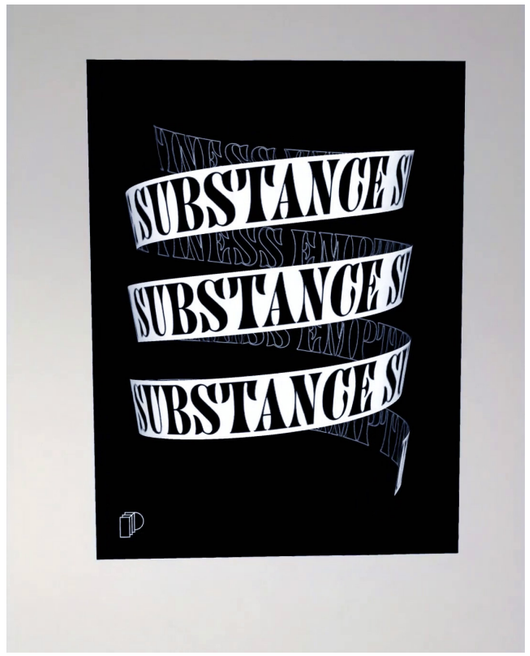
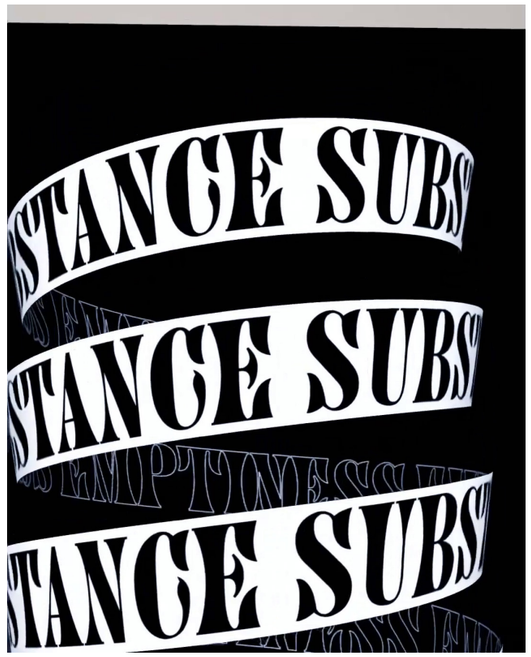


Fig. 52 – Post-print #01.

Experience this image in AR using the app **Post-print**





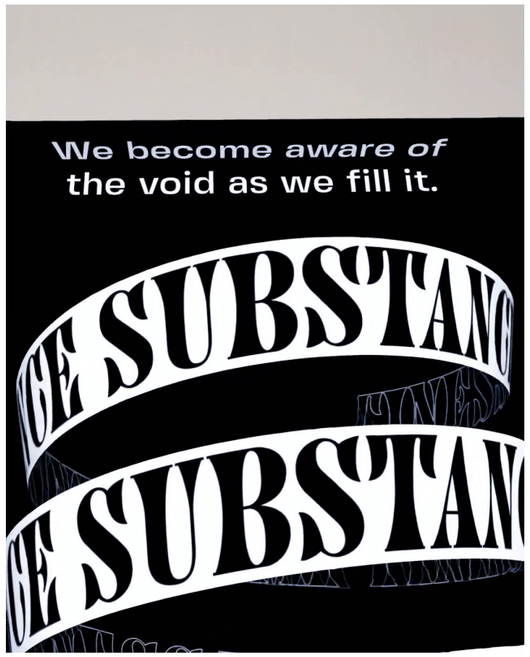


Fig. 53 – Post-print #01 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #02
DAZE

Your mind warps time, as it does the smell and sound and smells of reality.

The second AR experience features another hollow box where extra information is inserted behind the central geometry consisting of several rectangles that form the word '*daze*', seen only when looking from certain angles and when the central shape is twisting. It features a more complex setup in comparison to the previous poster due to a higher amount of objects, each one with a different image texture assigned.

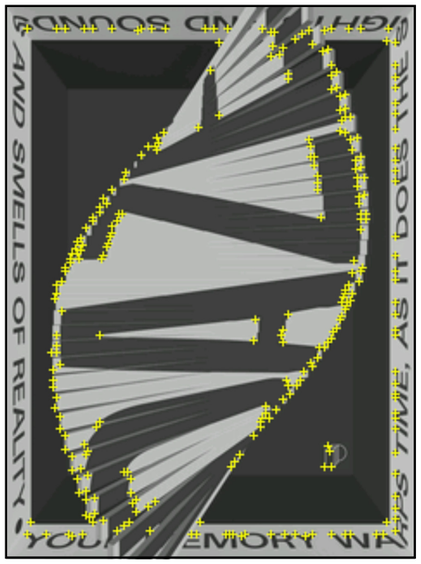


Fig. 54 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	3,829 KB
Polygon count	7522
Image textures	37
Images size	212 KB

Fig. 55 – Post-print #02.

Experience this image in AR using the app **Post-print**

Fig. 56 – Post-print #02 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #03
MUTUAL ATTRACTION

By revealing the second half of the message through AR, this poster displays the message '*mutual attraction*'. In an early version, due to the repetition of the words and low distortion besides the center part, the tracking quality was very low and often time the target would not be detected. This was overcome by a change in the target image, now alternating between filled and outlined words, which generated more variation and significantly improved detection speed and tracking quality.

TYPEFACE CONTRIBUTIONS

Adieu by Good Type Foundry

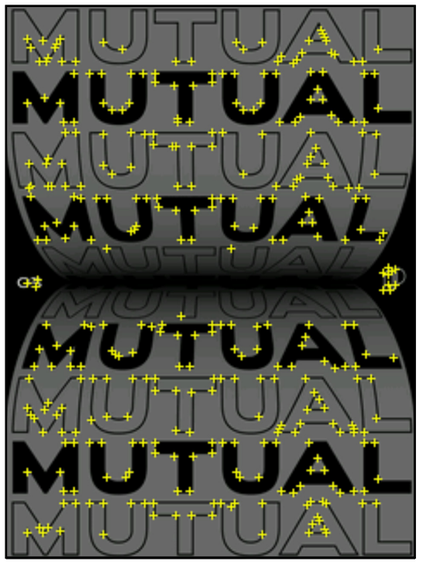


Fig. 57 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	444 KB
Polygon count	1409
Image textures	2
Images size	515 KB

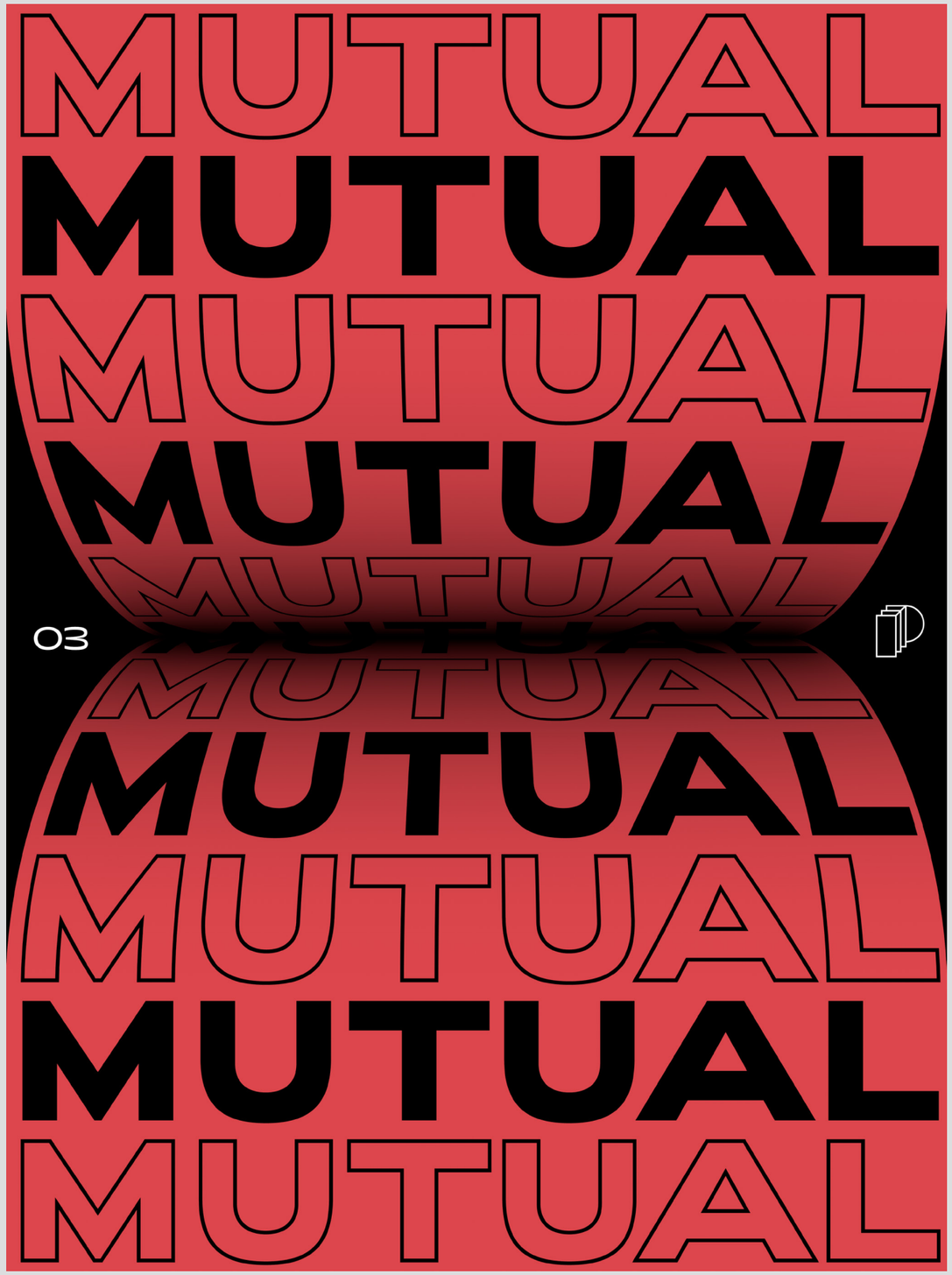


Fig. 58 – Post-print #03.

Experience this image in AR using the app **Post-print**

Fig. 59 – Post-print #03 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #04
RIGGED

The game is rigged, but you can't lose if you don't play.

The fourth experience displays the words *'The game is rigged'* placed clockwise in the page corners around a spherical grid aligned to the center. When scanned, the printed message pops from the page and the user can reveal the remaining words *'but you can't lose'* and *'if you don't play'*. Due to considerable wide empty areas, the tracking quality scores only 2 points, but the detection and tracking quality remain unaffected unless we zoom to said areas, where there are no tracking points.

TYPEFACE CONTRIBUTIONS

Integral by Connary Fagen

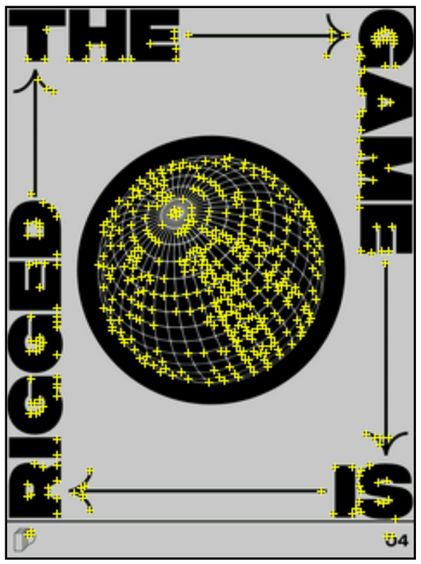


Fig. 60 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●○○○

GENERAL INFORMATION

3D file size	748 KB
Polygon count	36277
Image textures	2
Images size	26 KB

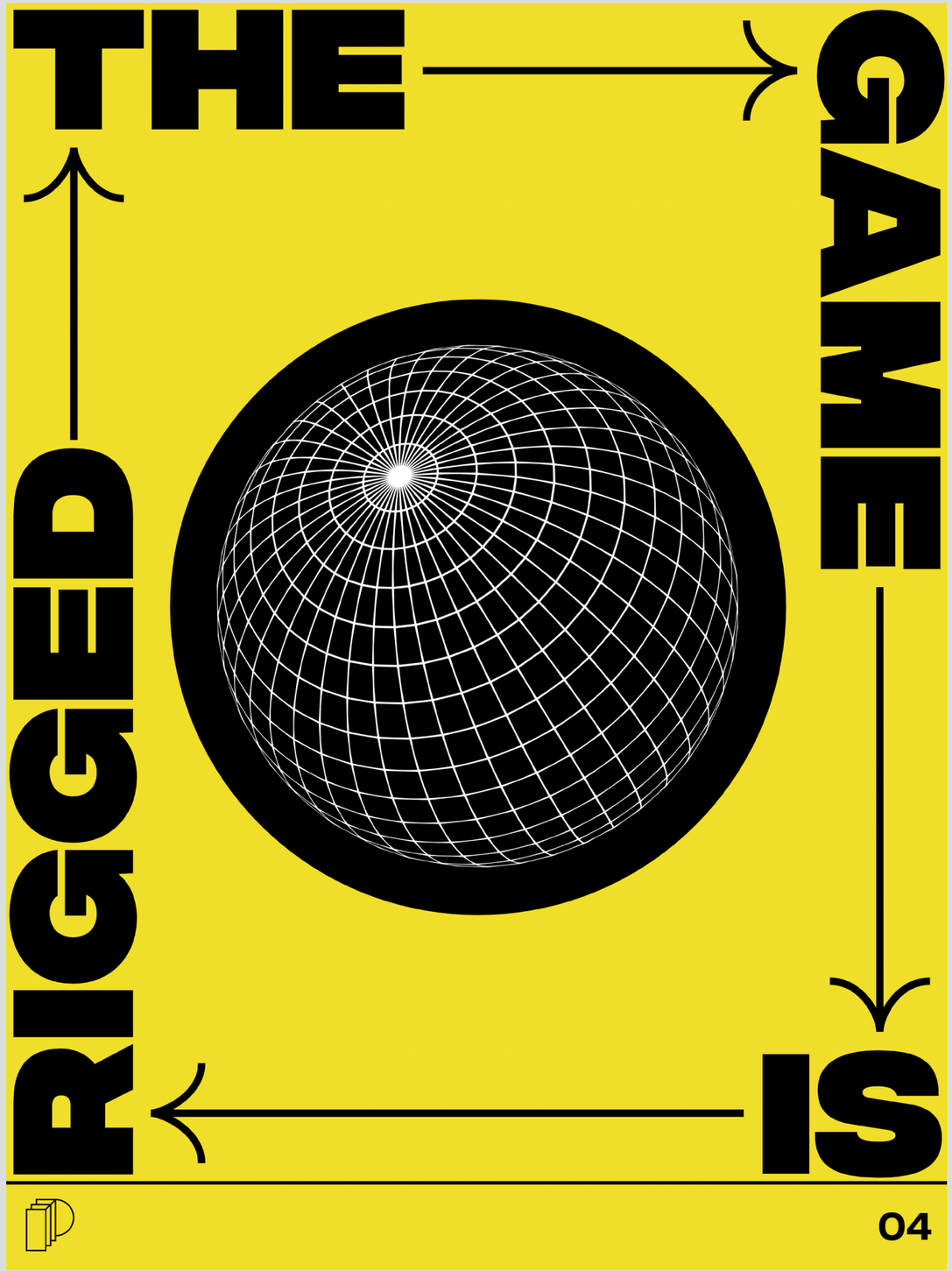


Fig. 61 – Post-print #04.

Experience this image in AR using the app **Post-print**

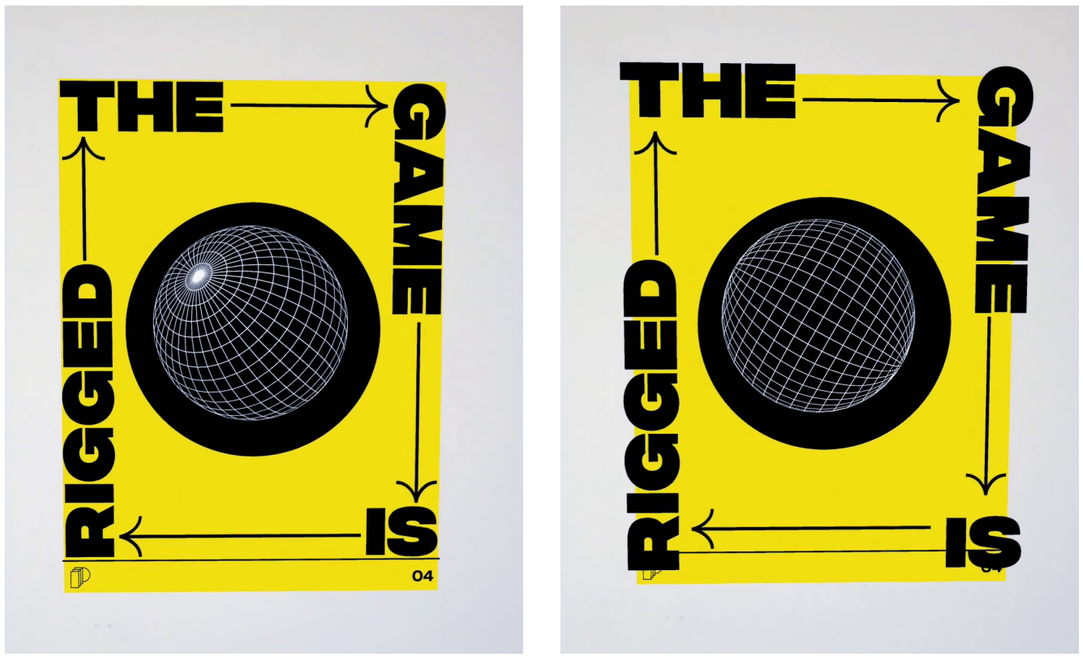


Fig. 62 – Post-print #04 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #05
MESS/LESS

Mess is more/
Less is more

This augmented poster changes completely upon scanning. The printed message displays *'less is more'* in a complex grid layout, which is then replaced by a simpler version that says *'less is more'*. The printed target contains the *'mess is more'* version because it has more details and complexity, which ultimately led to a much more reliable target. The animation here comprises a high number of individually animated elements which had a significant impacted the poster preparation time.

TYPEFACE CONTRIBUTIONS

Monitor Display by Diana Ferreira

Fig. 63 – Tracking point map.
Generated through the *Vuforia Developer Portal*

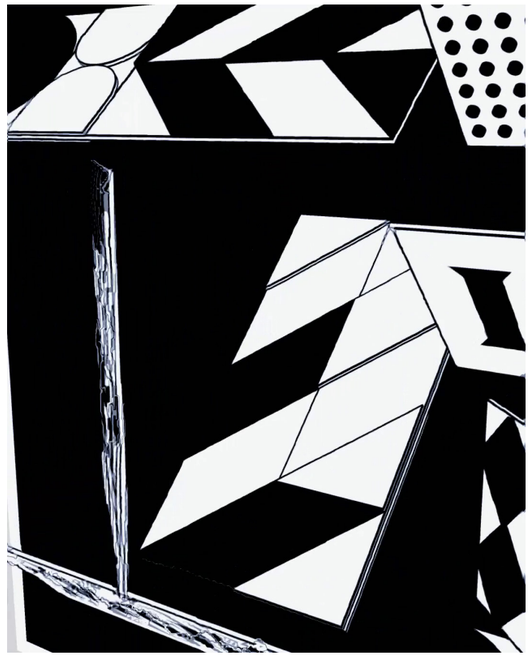
Tracking rating	●●●●●

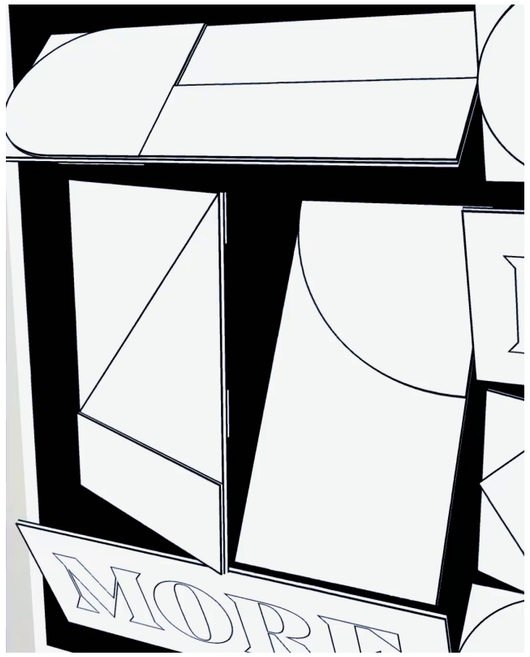
GENERAL INFORMATION

3D file size	2,427 KB
Polygon count	40821
Image textures	1
Images size	30 KB

Fig. 64 – Post-print #05.

Experience this image in AR using the app **Post-print**





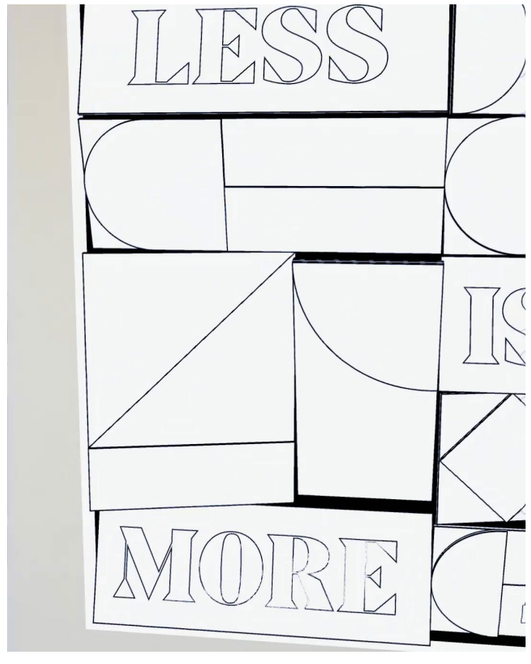


Fig. 65 – Post-print #05 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #06
EVERYTHING

... in it's right place.

Much like in the previous experience, the information is completely replaced upon scanning, showing *'Everything / in its right place'*. However, the change is more drastic due to orientation changes, as well as the introduction of a different background color. While using the computer screen or regular printed paper to display the target image, the tracking worked well. However, in the final light box, the tracking seems to have become worse, leading to delays of several seconds before the app is able to recognize the image. After a first scan this timing is reduced, but this proved to be important in the exhibition setting as some people skipped the poster if they weren't able to detect it in a timely manner. We believe this is caused by the printing technique, which was on a backlight surface and required color adjustment to try to match the desired colors. Since this process was done manually, it might not have been much accurate here and the blue tone seems to have become darker, which is most likely the cause for the tracking issues.

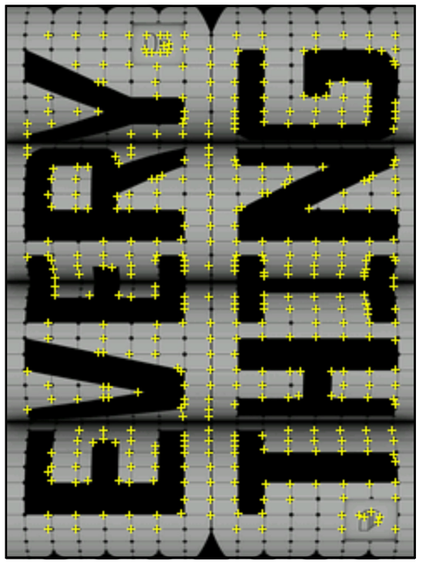


Fig. 66 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	2,774 KB
Polygon count	29686
Image textures	11
Images size	916 KB

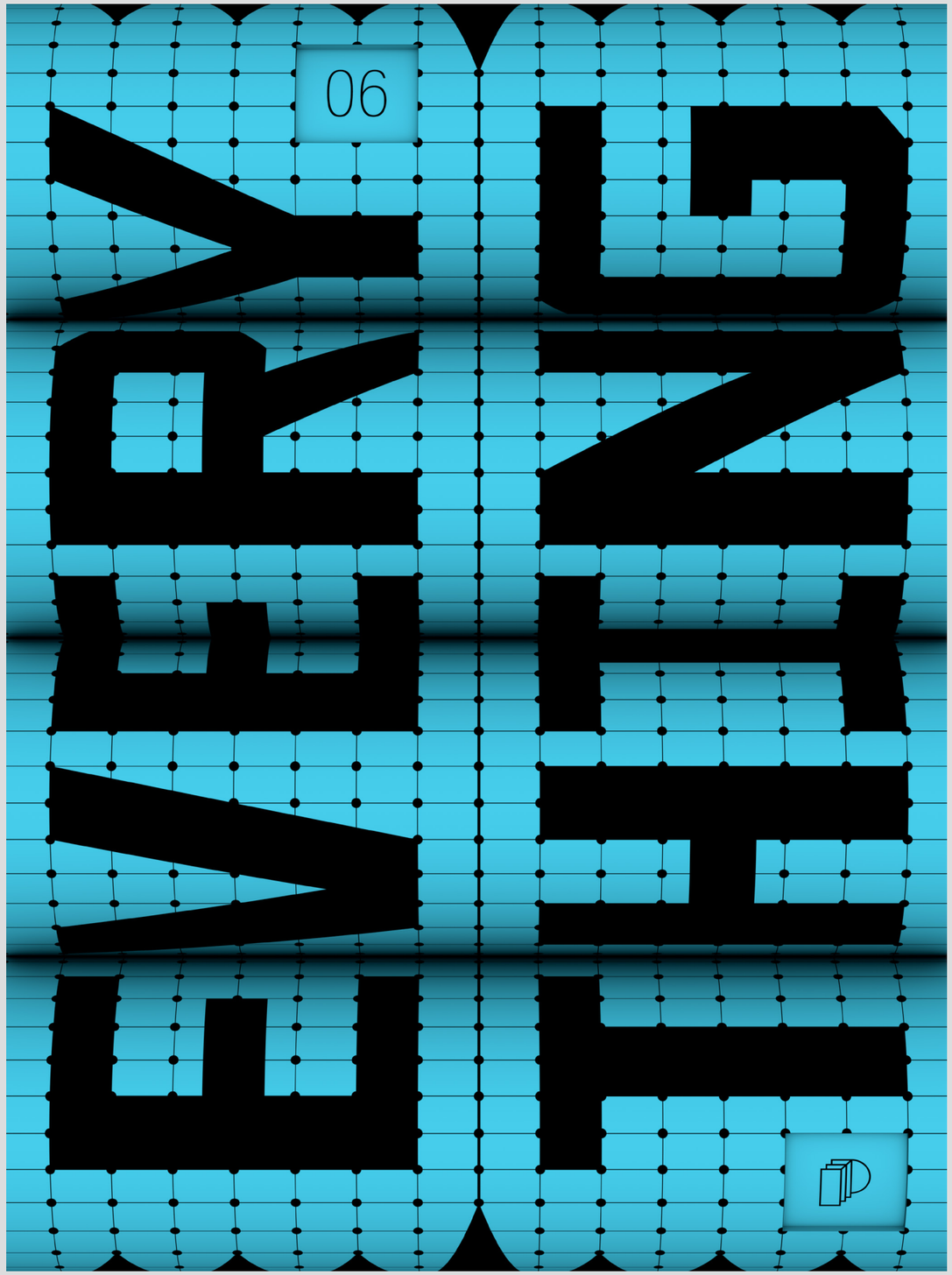
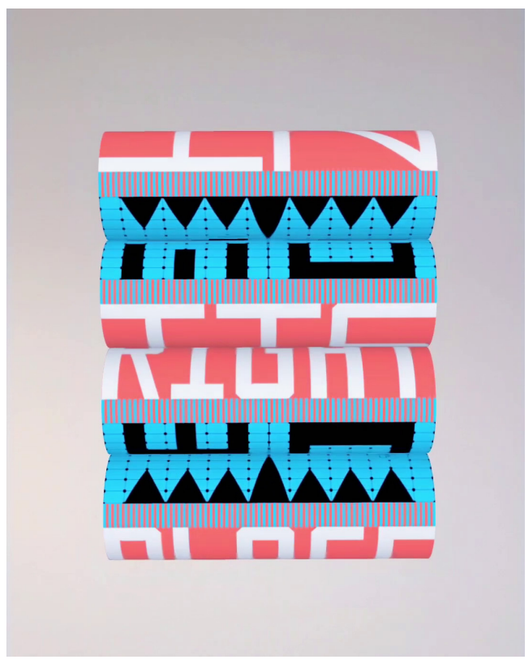
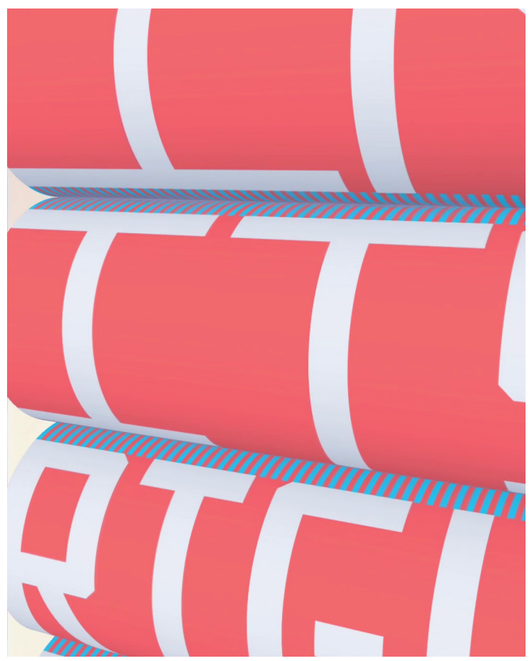


Fig. 67 – Post-print #06.

Experience this image in AR using the app **Post-print**





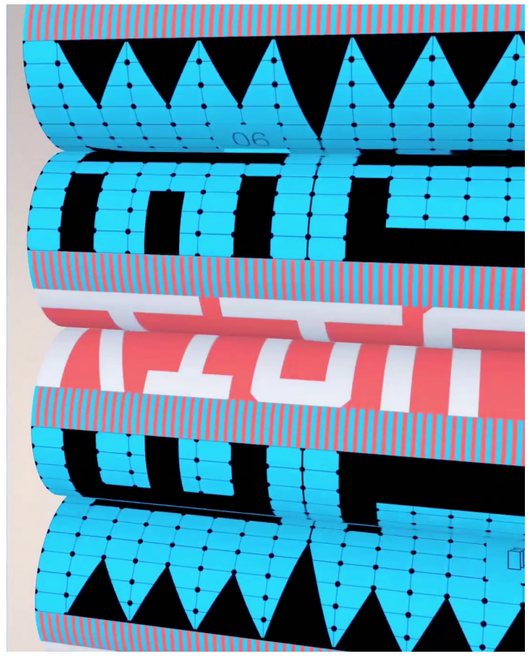


Fig. 68 – Post-print #06 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #07
INVISIBLE THREADS

What you seek is seeking you.

This poster contains two separate messages: *'Invisible Threads'* and *'What you seek is seeking you'*. The second message is revealed on the two moebius shapes through texture scrolling, using the C# script previously created. The movement in these two shapes gives the viewer an optical illusion that was achieved by rotating the geometry clockwise, while the texture scroll speed has negative values, making them move counterclockwise. By matching boths speeds, the shapes appear to be twisting infinitely.

TYPEFACE CONTRIBUTIONS

Arre by Gonçalo Fialho

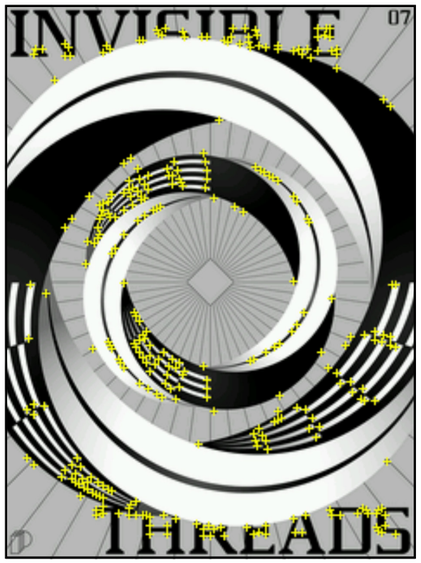


Fig. 69 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	1,054 KB
Polygon count	11382
Image textures	5
Images size	137 KB

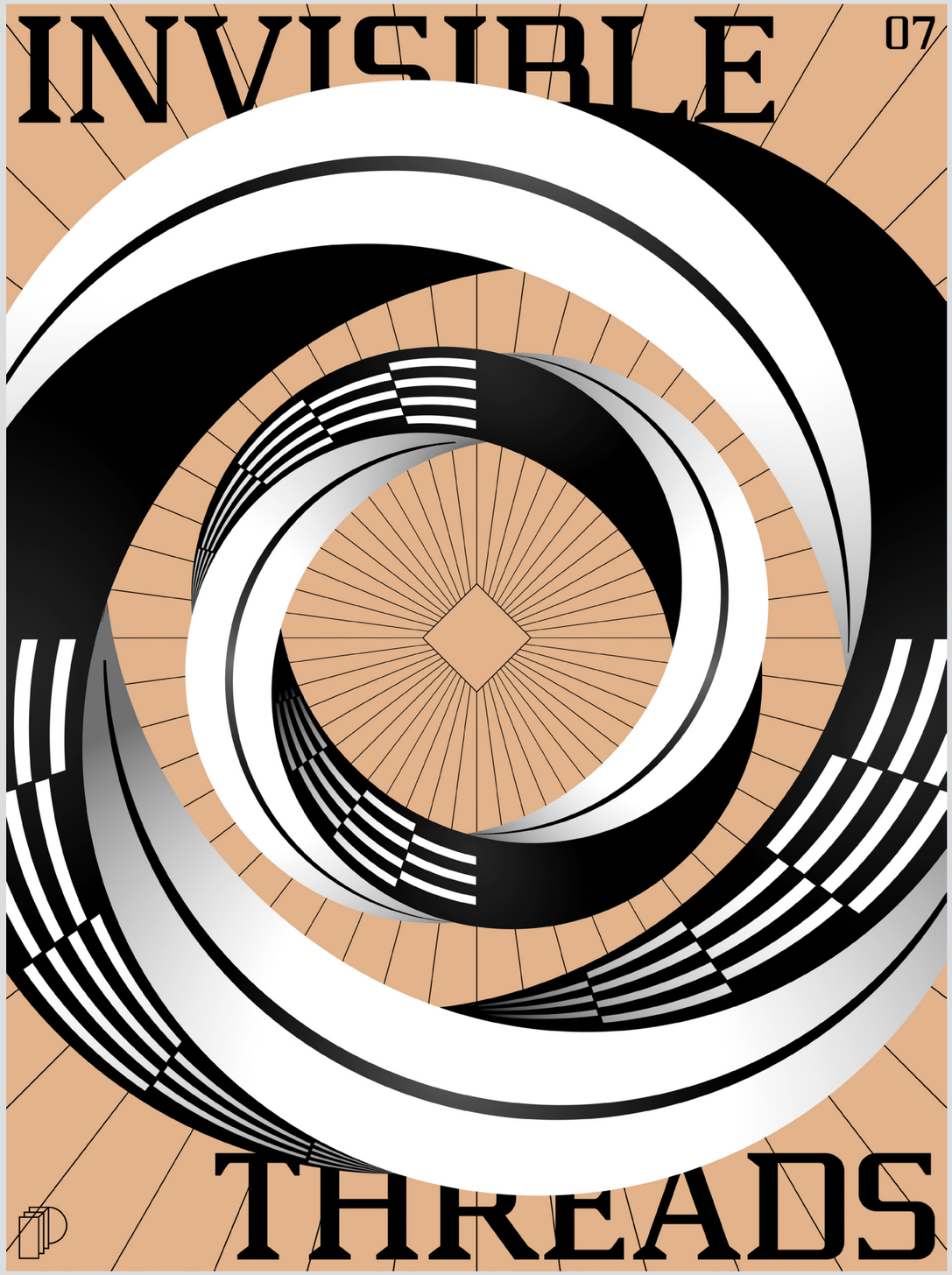


Fig. 70 – Post-print #07.

Experience this image in AR using the app **Post-print**

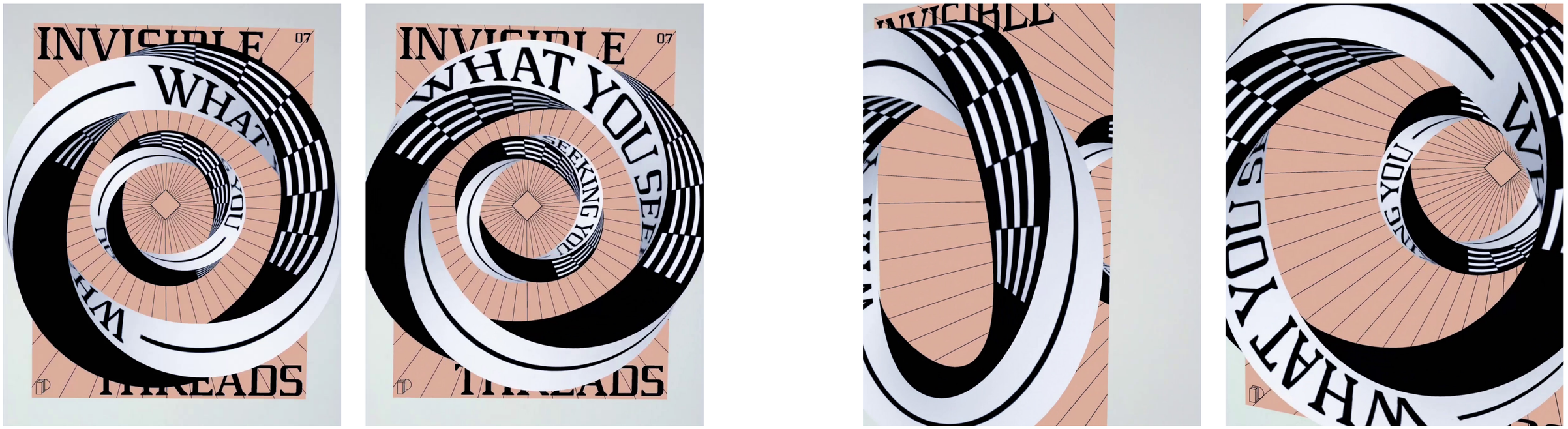


Fig. 71 – Post-print #07 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #08
PARADIGM–SHIFTING

Massive alteration.

This is the first experience where the message is almost completely unreadable in the printed target. The viewer is required to see it in 3D to reveal a message placed on an invisible, rotating cylindrical shape: '*Paradigm-shifting*'. A second cylinder which is slightly tilted and rotating in the opposite direction also contains a second message: '*massive alteration*'. In an exhibition setting, the fact it can only be read using the app is not considered a problem, since the viewer is supposed to be using it to view the content. However, in a real word scenario, as in a design project that is communicated to a wider audience in a public setting, we believe that the main information should be readable in the printed target, while secondary info could be added through AR. This is due to the fact that not everyone will have the app installed beforehand and downloading on the go might not be an option due to mobile data plan restrictions.

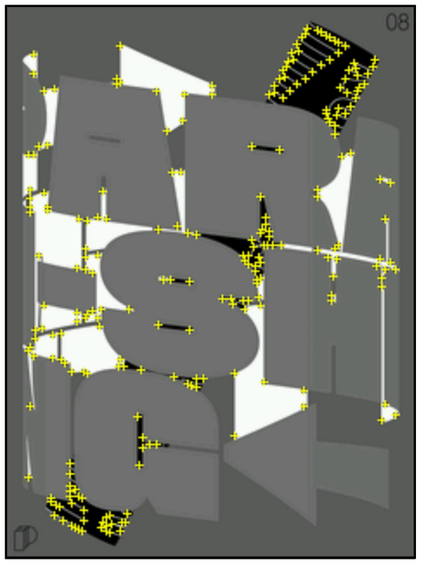


Fig. 72 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	1,161 KB
Polygon count	8432
Image textures	3
Images size	110 KB

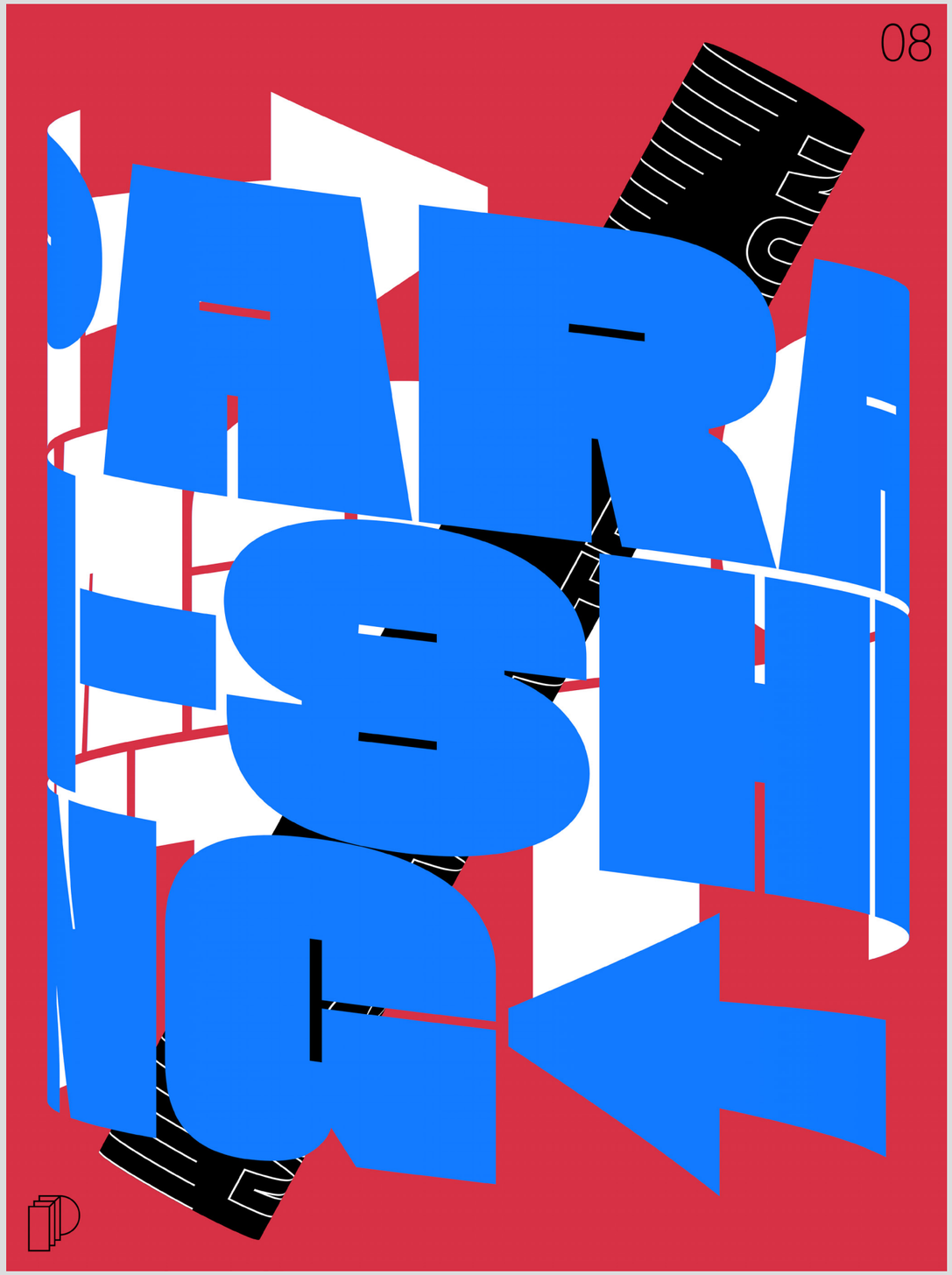
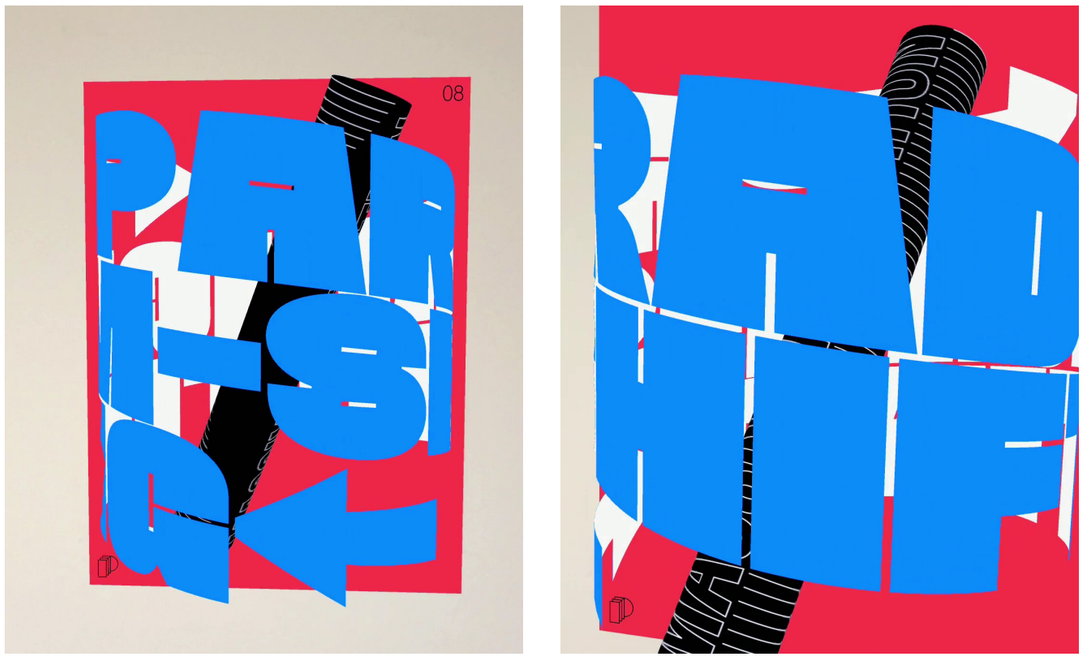
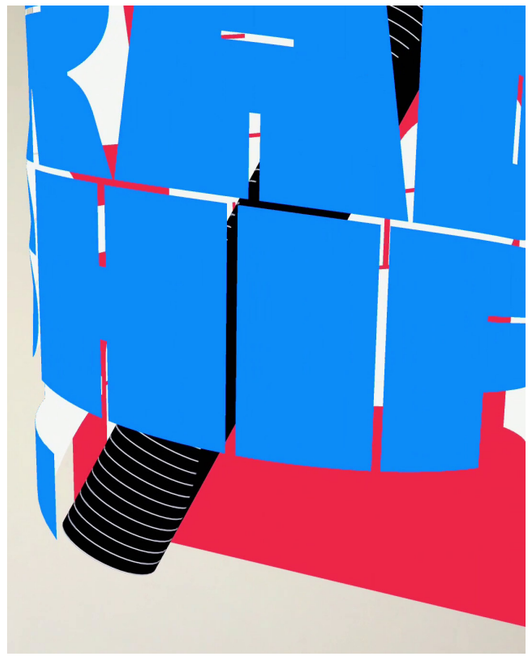
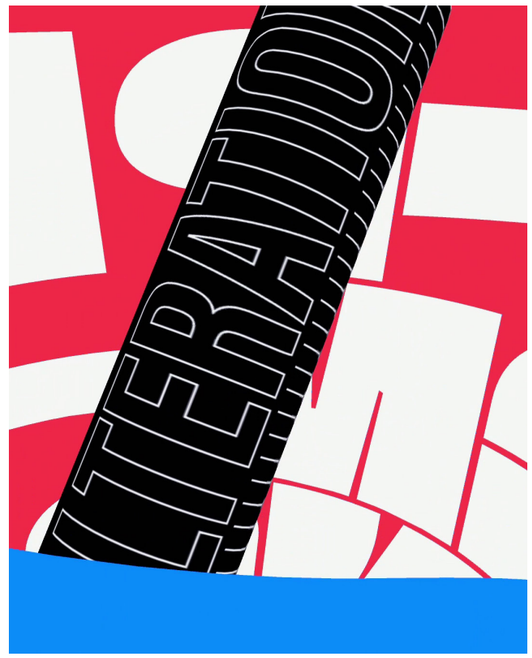


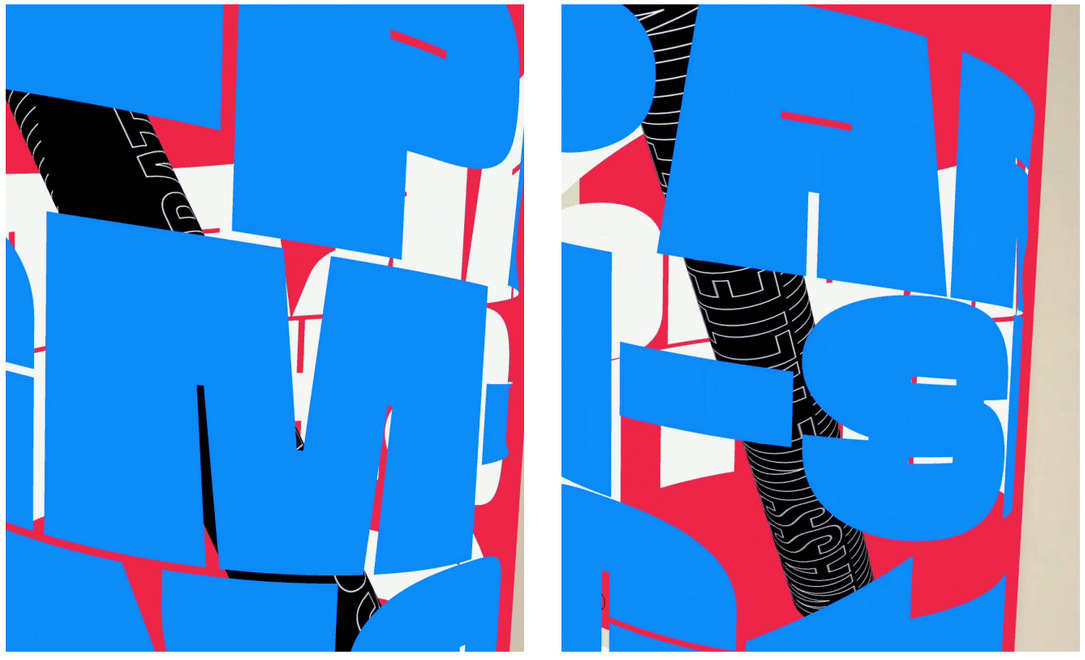
Fig. 73 – Post-print #08.

Experience this image in AR using the app **Post-print**









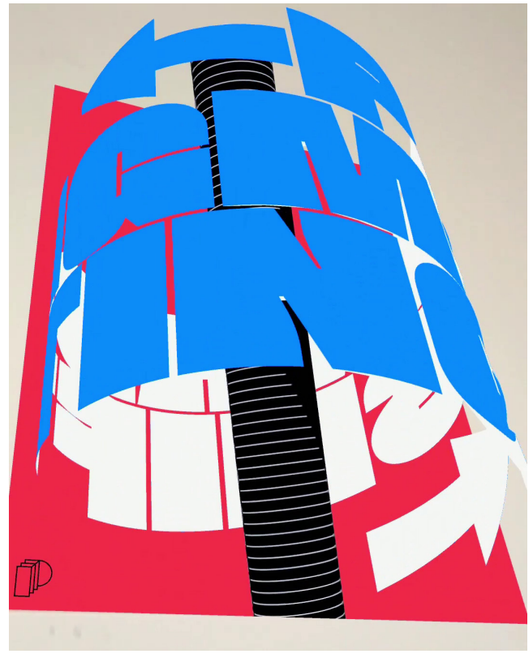


Fig. 74 – Post-print #08 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #09
TRUTH

(Never) simple, (rarely) pure.

The ninth poster mimics an infinity mirror behaviour, by stacking multiple layers on the Y axis, for the word *'Truth'*. This word is repeated and alternates between outline and fill due to tracking issues. The first version had the word only once, with more condensed letters that would take up the same space, but the lack of detail in that center area was making the tracking unstable. It's one of the posters where the technical restrictions had a direct impact on the final design decisions. In the augmented version, two rectangular shapes move inwards, revealing additional words, transforming the message from *'pure, simple'* to *'never simple, rarely pure'*.

TYPEFACE CONTRIBUTIONS

SM Häuser by Mark Niemeijer (Soft Machine Type Foundry)

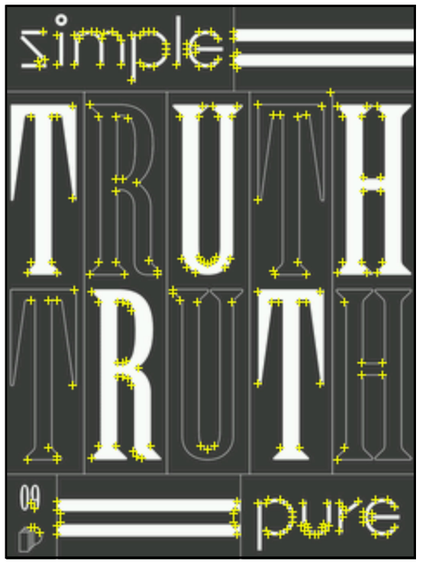


Fig. 75 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	1,074 KB
Polygon count	9203
Image textures	9
Images size	303 KB

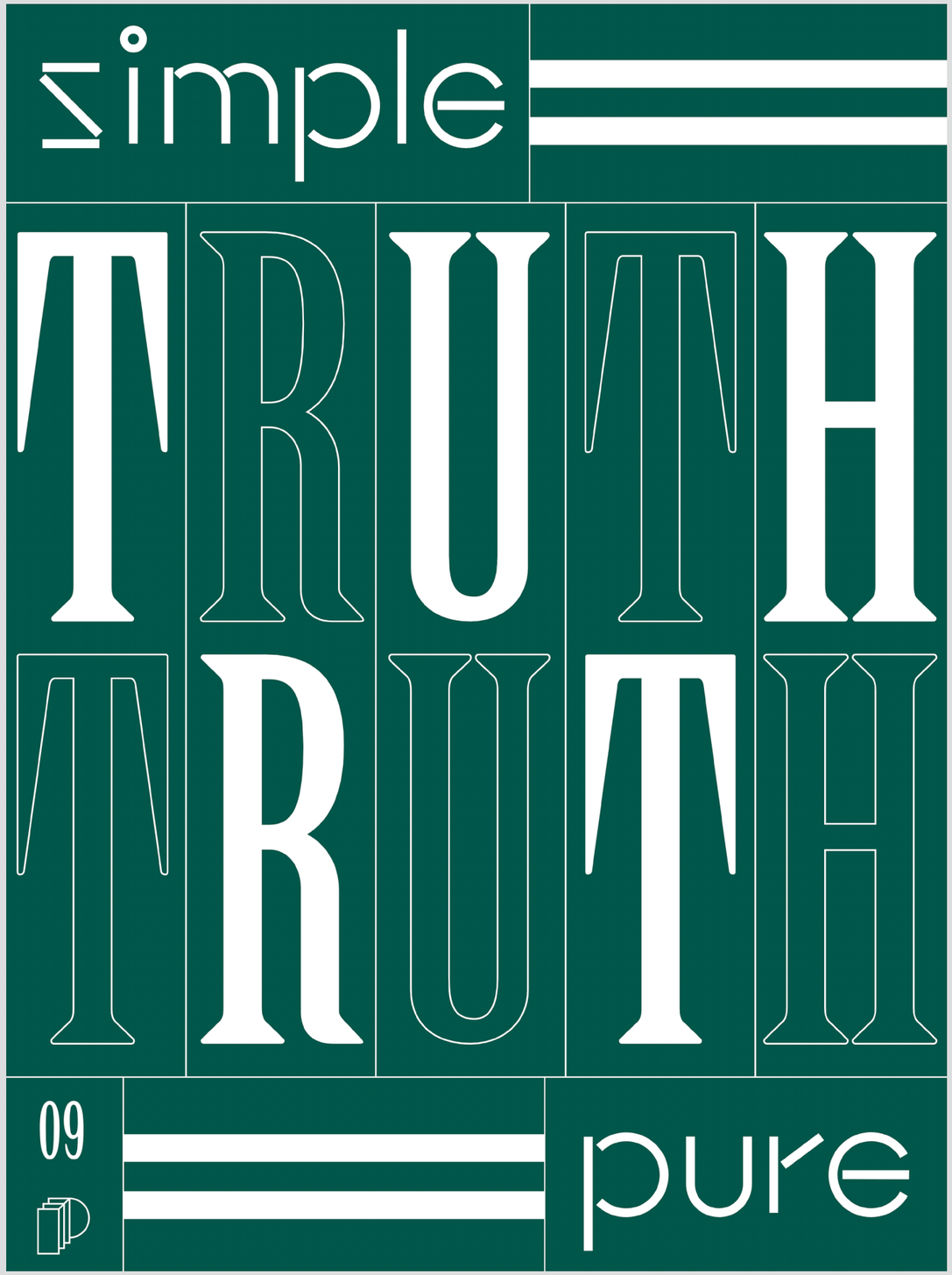


Fig. 76 – Post-print #09.

Experience this image in AR using the app **Post-print**

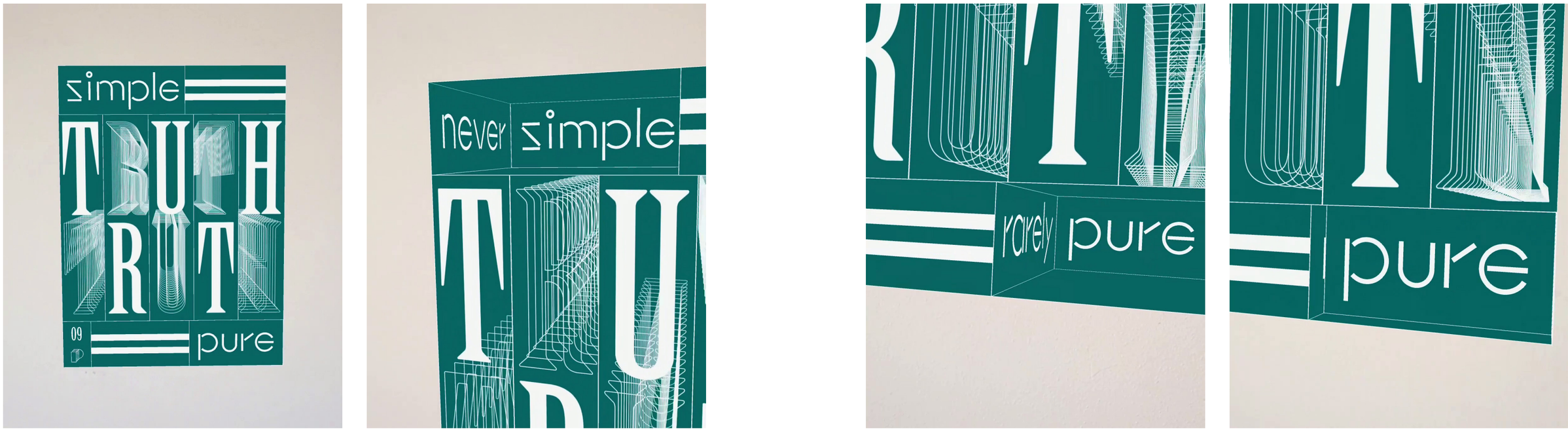


Fig. 77 – Post-print #09 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #10
NOTHING HAPPENS

... until something moves.

Poster number ten reveals the second part of the message *'until something moves'* in the augmented counterpart. Due to its simplicity in design, we had to add extra elements, the number 09 and an arrow, in the upper right hand, for improved tracking.

TYPEFACE CONTRIBUTIONS

Morion by David Einwaller (The Designer's Foundry)

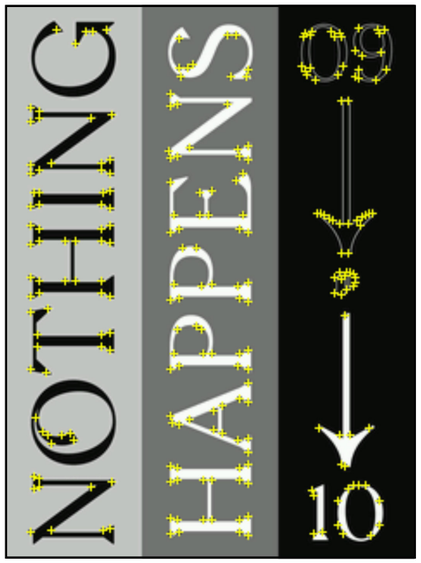


Fig. 78 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	665 KB
Polygon count	141
Image textures	13
Images size	340 KB

Fig. 79 – Post-print #10.

Experience this image in AR using the app **Post-print**

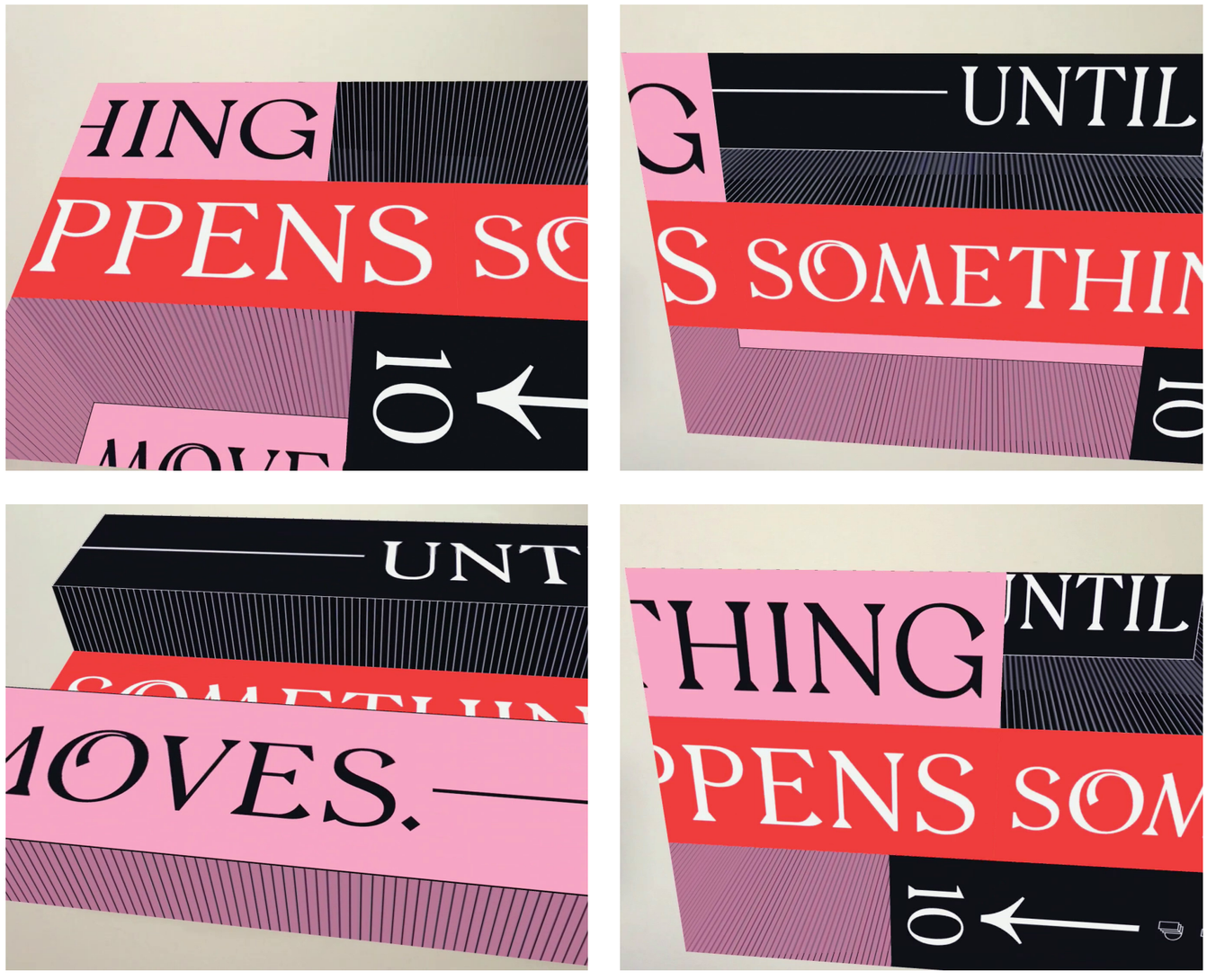


Fig. 80 – Post-print #10 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #11
MIND AWAKE

Body asleep.

This experience forms the sentence *'Mind awake, body asleep'*, also divided in two parts. The printed target features a bright yellow, but through animation in AR the colors are inverted and when 'body asleep' is revealed, the background goes pitch black. It is possible to reveal the words 'threshold consciousness' by tilting the phone upwards and downwards. There is a new method of animation in this poster that consists in the use of a script (PNG sequencer) to scroll between multiple PNG frames, which provides the fade in/fade out effect in the colors. This script was not used on any other poster because we found it to be quite heavy in terms of processing, mostly because it's constantly running in the background, even if the poster is not being scanned. The tracking works well despite having a considerable amount of empty space, mostly due to the highly detailed typography that provides additional tracking points.

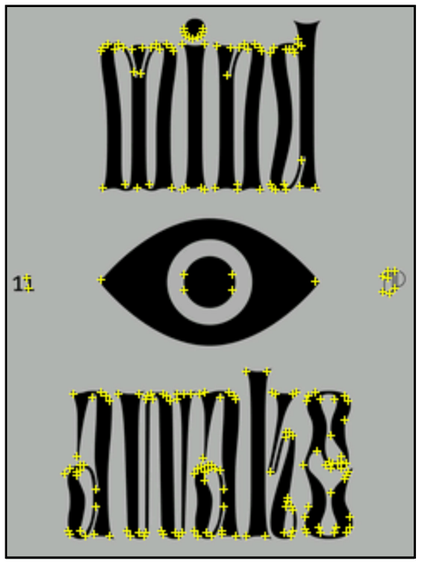


Fig. 81 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	754 KB
Polygon count	1744
Image textures	247
Images size	1,096 KB

TYPEFACE CONTRIBUTIONS

Digestive by Jérémy Landes (Studio Triple)

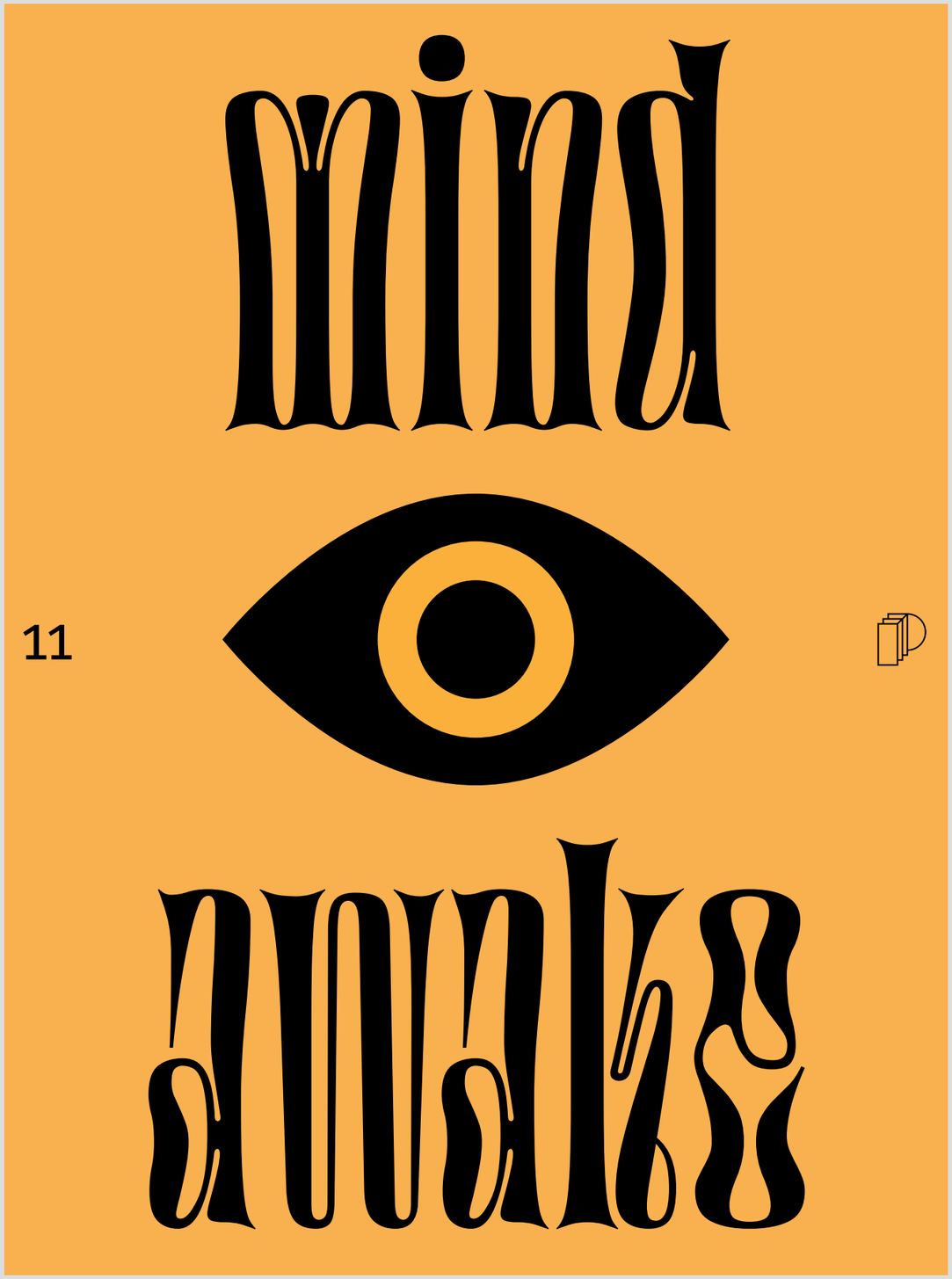


Fig. 82 – Post-print #11.

Experience this image in AR using the app **Post-print**

Fig. 83 – Post-print #11 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #12
PERCEPTION

It's about time we changed our perception of reality.

This experience alternates between two parts of the sentence *'It's about time we changed our perception of reality'*. It proved to be one of the most successful posters mostly due to the center sphere that comes out of the poster and significantly enhances the sense of 3D. The viewers were impressed and usually spent more time in this poster. The animation also swaps between the high contrast monochrome color scheme to a brighter palette.

TYPEFACE CONTRIBUTIONS

Grandmaster by Lucas Descroix (The Designer's Foundry)

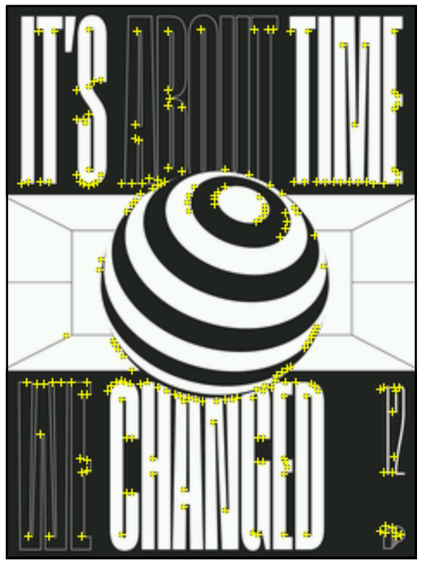


Fig. 84 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	787 KB
Polygon count	3892
Image textures	10
Images size	318 KB

Fig. 85 – Post-print #12.

Experience this image in AR using the app **Post-print**

Fig. 86 – Post-print #12 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #13
REPETITION

... is a form of change.

Displaying only the word 'REPETITION' on the printed target, this poster reveals an additional message upon scan - 'IS A FORM OF CHANGE'. The construction is similar to poster 11, but with more emphasis on the cylinder's three dimensionality. By aligning the center of the 3D object to the target plane position, it stands halfway in and halfway out of the page. To enhance the tracking quality we alternated between fill and outline on each line. With the distortion of the letters on the 3D cylinder and the varied rotation on each segment, we achieved enough variation to provide a stable experience.

TYPEFACE CONTRIBUTIONS

Prophet by Dinamo Typefaces

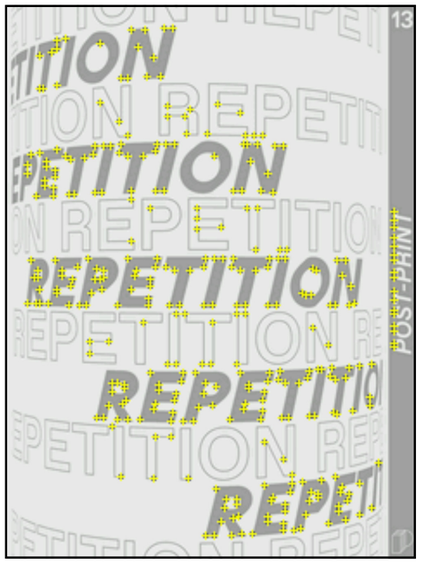


Fig. 87 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●○

GENERAL INFORMATION

3D file size	749 KB
Polygon count	5047
Image textures	9
Images size	885 KB

Fig. 88 – Post-print #13.

Experience this image in AR using the app **Post-print**

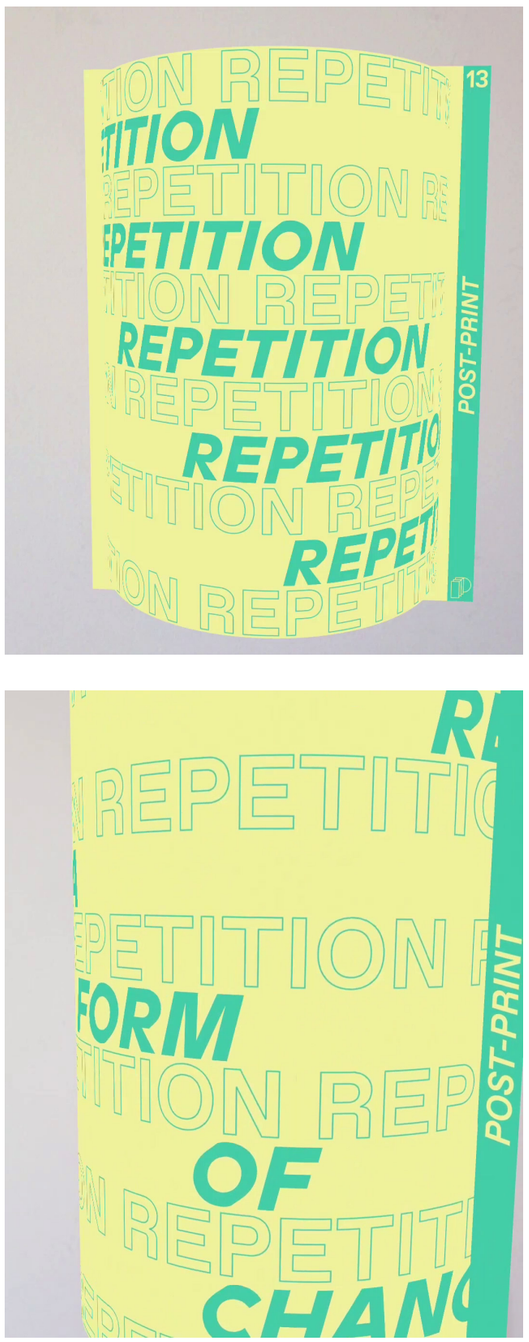


Fig. 89 – Post-print #13 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #14
SPACE-TIME DISCONTINUUM

Nowadays we all communicate in a space-time discontinuum.

This experience presented several problems regarding tracking. In the first version, the printed target contained just the spiral 3D shape. Due to its positioning and lack of perspective distortion obtained through the use of a front parallel view, created a high area of empty space. The tracking was notably bad and it had problems event detecting the poster. After multiple iterations, this issue was fixed by adding the part of the message — which was first meant to be seen only in AR — to the printed target, repeated vertically.

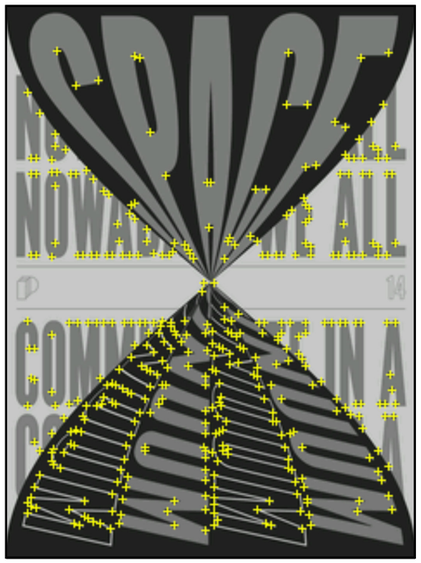


Fig. 90 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	3,379 KB
Polygon count	39932
Image textures	5
Images size	1,860 KB

Fig. 91 – Post-print #14.

Experience this image in AR using the app **Post-print**

Fig. 92 – Post-print #14 AR experience snapshots. Full video available at *instagram.com/post.print*

POSTER #15
ORDER

Behind a false face of order is an invisible code of chaos.

The fifteenth and final poster makes use of one of *Unity*'s rendering characteristics, which is the fact that only the front side of a polygon is rendering. This means that a flat plane with no thickness will only be visible if we look at it's front side. The faces containing 'BEHIND / A FALSE / FACE OF / ORDER' are invisible if we look at the poster from below, allowing the viewer to see past them.

TYPEFACE CONTRIBUTIONS

Faktura by Futur Neue

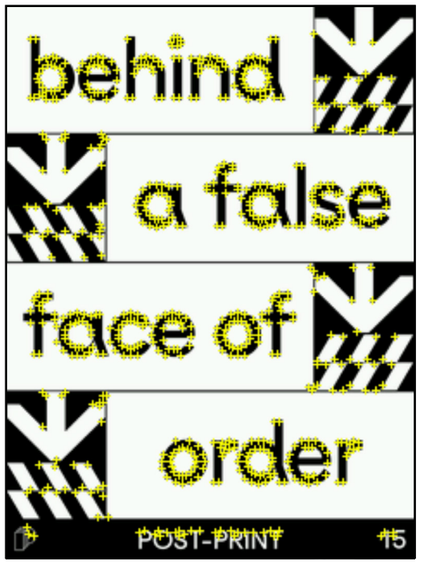


Fig. 93 – Tracking point map.
Generated through the *Vuforia Developer Portal*

Tracking rating	●●●●●

GENERAL INFORMATION

3D file size	1,355 KB
Polygon count	5576
Image textures	25
Images size	603 KB

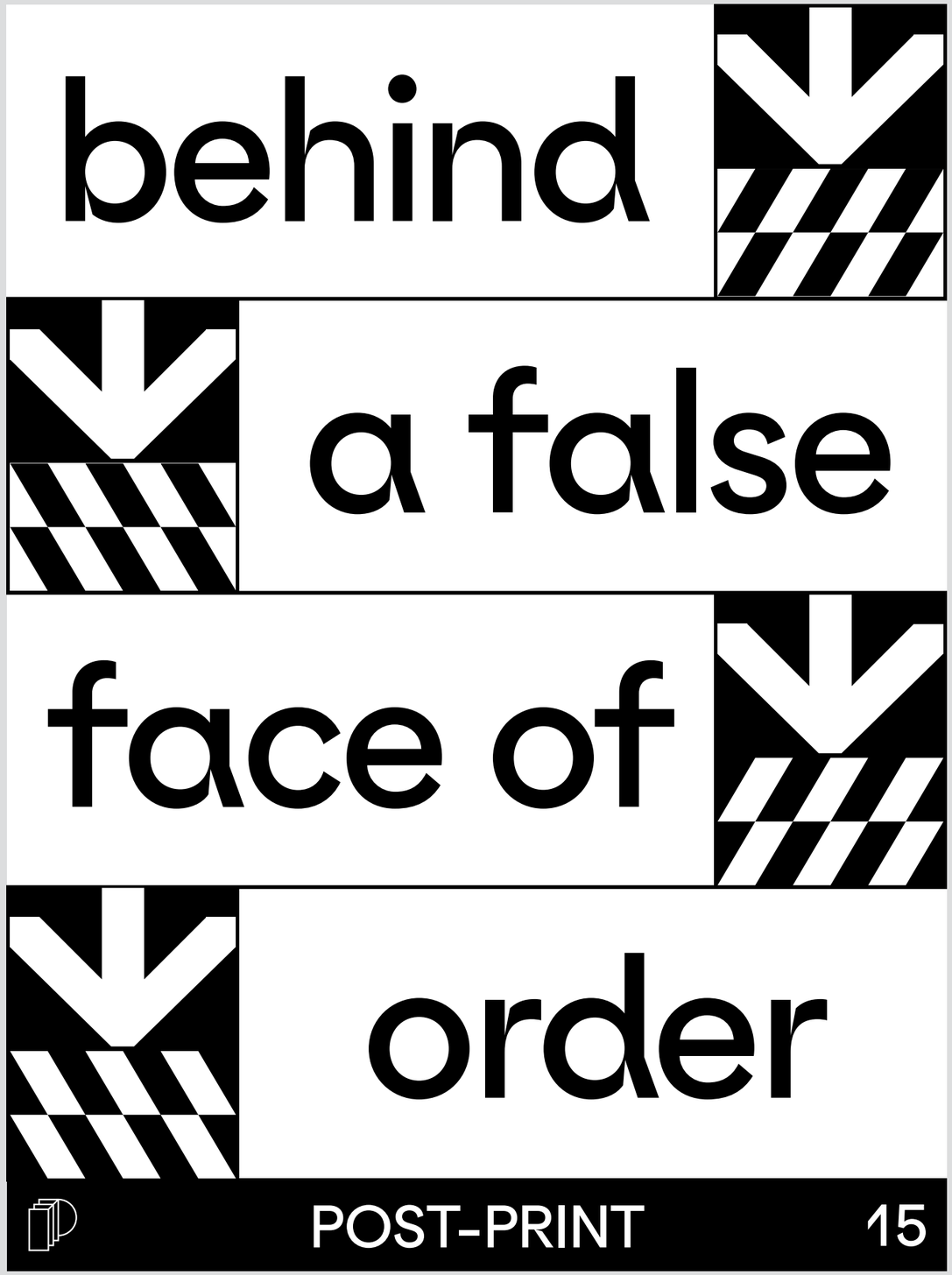


Fig. 94 – Post-print #15.

Experience this image in AR using the app **Post-print**

Fig. 95 – Post-print #15 AR experience snapshots. Full video available at *instagram.com/post.print*

4.8. APP DESIGN AND FUNCTIONALITY

The early versions of the app did not include any functionality besides the AR camera that triggered the experiences. It was considered positive to include a basic menu with information on how to use the app and some information about the project goal as well as buttons to the Instagram page and website. By adding this basic content, we also ensured we would meet *App Store*'s minimum requirements. While *Play Store* accepts most apps, *App Store* includes a team that reviews each submission. If the app does not present some basic information about it it could be rejected from the store.

The first version of the UI (Fig. 96) consisted on a full-screen menu that allowed the user to get to know the project: how to use, about the project, typographic contributions and special thanks. The AR camera feed was launched with the Start button.

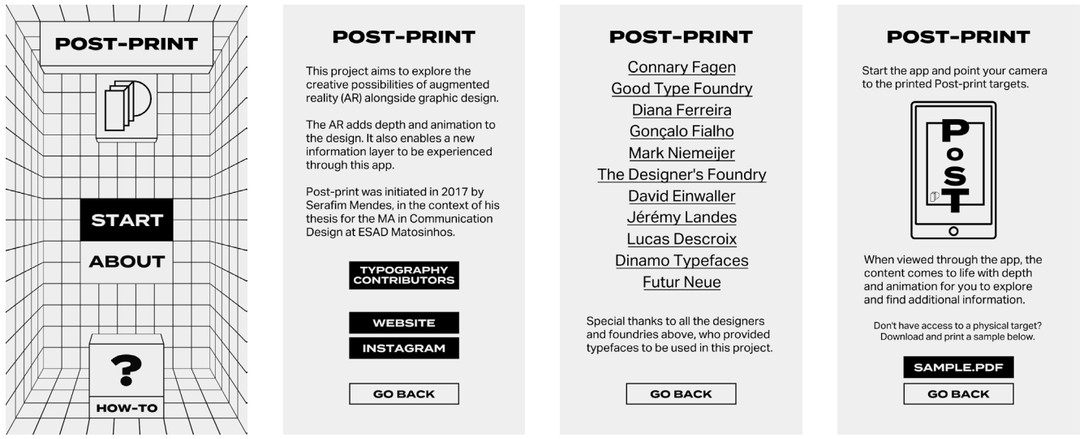


Fig. 96 – Initial Post-print user interface.

This version of the app was accepted in both stores, but the separation between that menu and the AR experiences was later considered unnecessary. A second version of the UI (Fig. 97) was made as an overlay to the camera feed. The app shows a pop-up with three steps that explain basic functionality, and more information can be obtained by tapping the information (i) icon. By doing that a new window pops up containing four buttons: About, Typography, Special Thanks and a link to a Sample Target (PDF file) with five of the fifteen posters that people can print on their own and try, in absence of the exhibitions.

Fig. 97 – Final Post-print user interface.

Since every user is able to interact with the poster uniquely the final version includes a screen recording button allowing the user to record up to 15 seconds of footage, generating a MP4 video in their device. This was implemented in both *iOS* and *Android* versions with the aid of *NatCorder*, a screen recording API for *Unity*.

4.9. FINAL EXHIBITION

After designing fifteen AR posters/experiences a final exhibition was planned. The final host came from a contact with *Mecha Studio*, an interactive media studio, whose interests were aligned with this project's concept. Mecha offered to host the event in their own studio (Fig. 98) located at the heart of the city.

Fig. 98 – Mecha Studio entrance during the exhibition opening.

The studio also offered to design the exhibition installation that would showcase the printed posters. The main purpose was to create a structure that enhanced and fit the AR content. Since the posters have different depths in the AR animation either entering or exiting the surface of the poster it was decided to work with boxes instead of placing the posters in a wall to enhance the dimensionality and sense of depth.

The boxes, made with black and white acrylic, contained LED strips that ensured high contrast and visibility even on dark environments. The boxes were placed on an iron structure hung from the ceiling that contained the *Post-print* symbol (Fig. 99). The posters were printed on backlit film, taking advantage of the light inside the installation modules. The colors were once again slightly adjusted to match the app colors with the physical targets when fully lit.

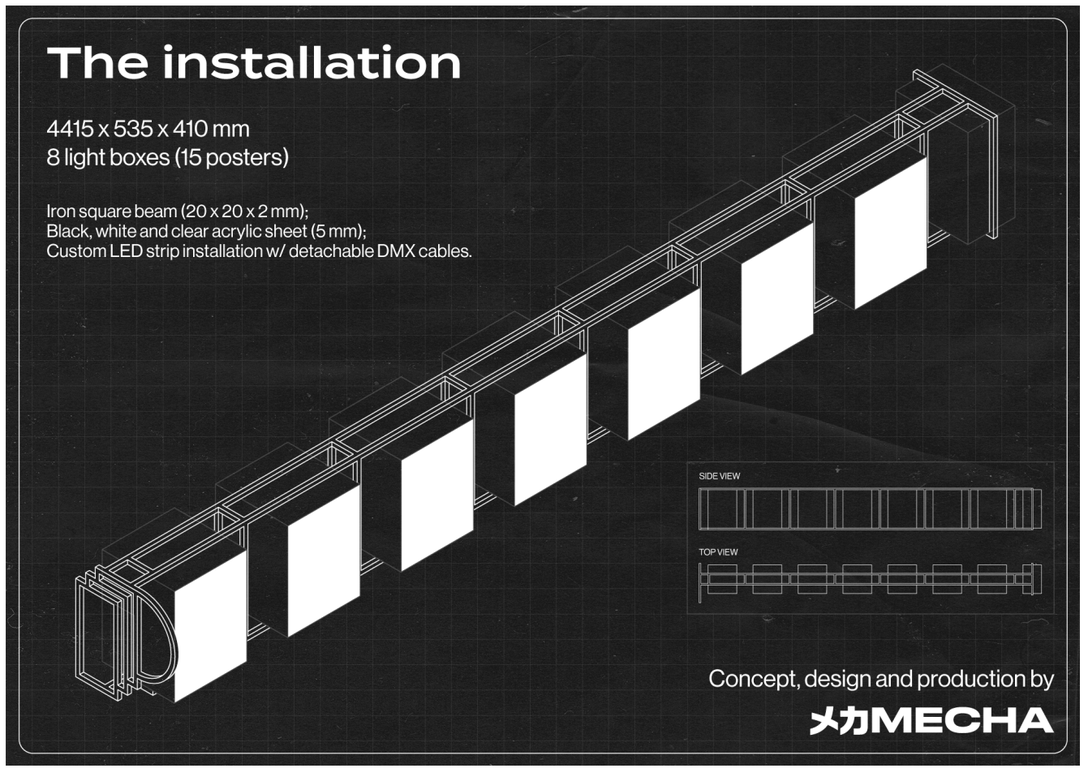


Fig. 99 – Exhibition installation by Mecha Studio.

The main event was held on October 26, 2018 at *Mecha Studio* and it was considered a success. It counted with the attendance of a high number of people and very positive feedback. The event was planned for a single day but due to multiple requests the exhibition was reopened the day after. That second moment had less participation but was still reasonably crowded and offered a second chance to people who could not make it in the official date. The screen recording functionality was very helpful since a high number of attendants shared on social media channels, mostly Instagram stories, which brought a considerable amount of attention and new followers to the project. The app ranked no. 2 at *Play Store*, in the category Trending/Arts & Design and no. 78 at the *App Store*, in the category Photography and Film, during the first day of exhibition. The exhibition later moved to *ESAD Matosinhos*, taking place from December 12, 2018 to March 8, 2019.

Fig. 100 – Post-print exhibition. Photography by Inês Leal.

Fig. 101 – Post-print exhibition. Photography by Inês Leal.

Fig. 102 – Post-print exhibition. Photography by Inês Leal.

Fig. 103 – Post-print exhibition. Photography by Inês Leal.

Fig. 104 – Post-print exhibition. Photography by Inês Leal.

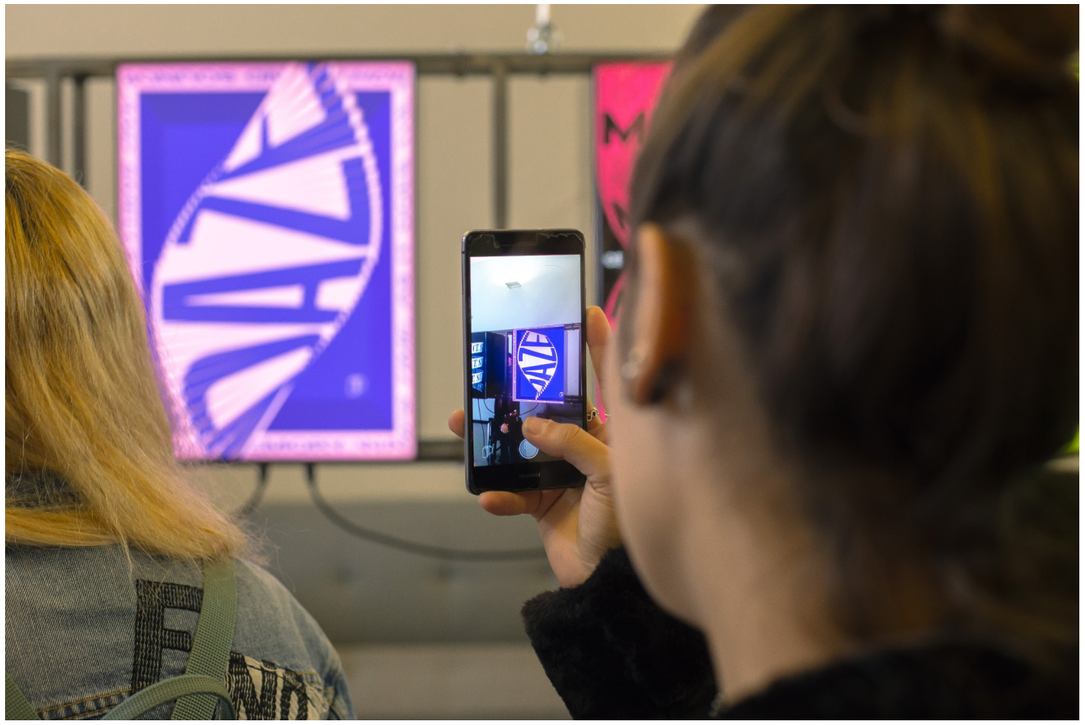


Fig. 105 – Post-print exhibition. Photography by Inês Leal.

Fig. 106 – Post-print exhibition. Photography by Inês Leal.

Fig. 107 – Post-print exhibition. Photography by Inês Leal.

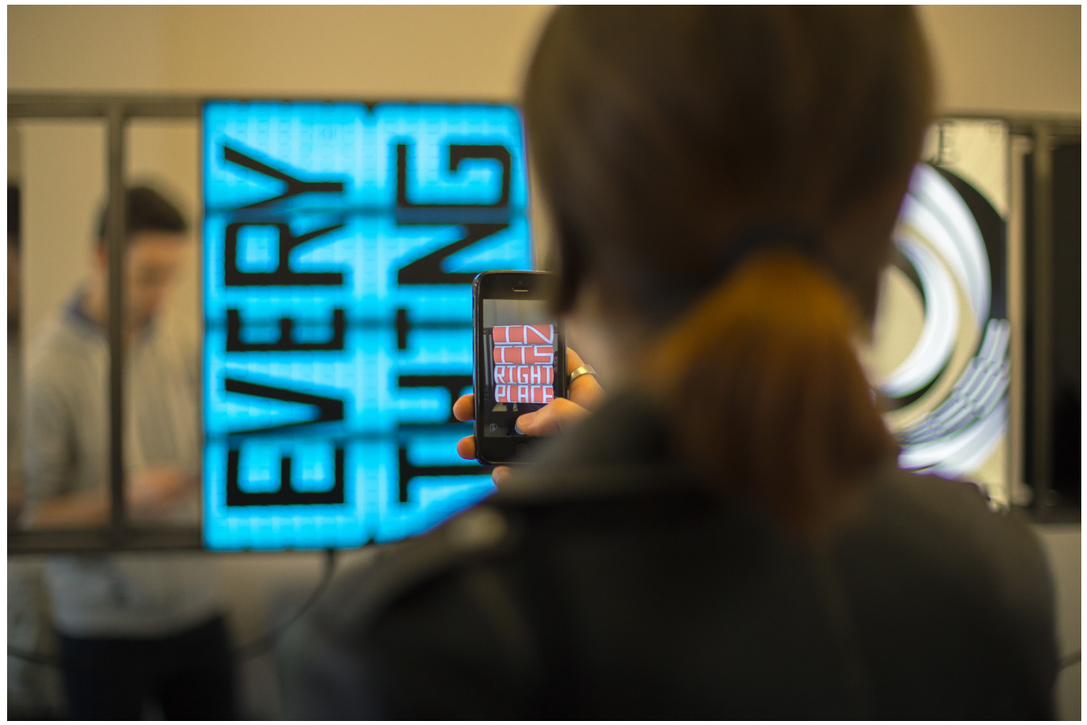


Fig. 108 – Post-print exhibition. Photography by Inês Leal.

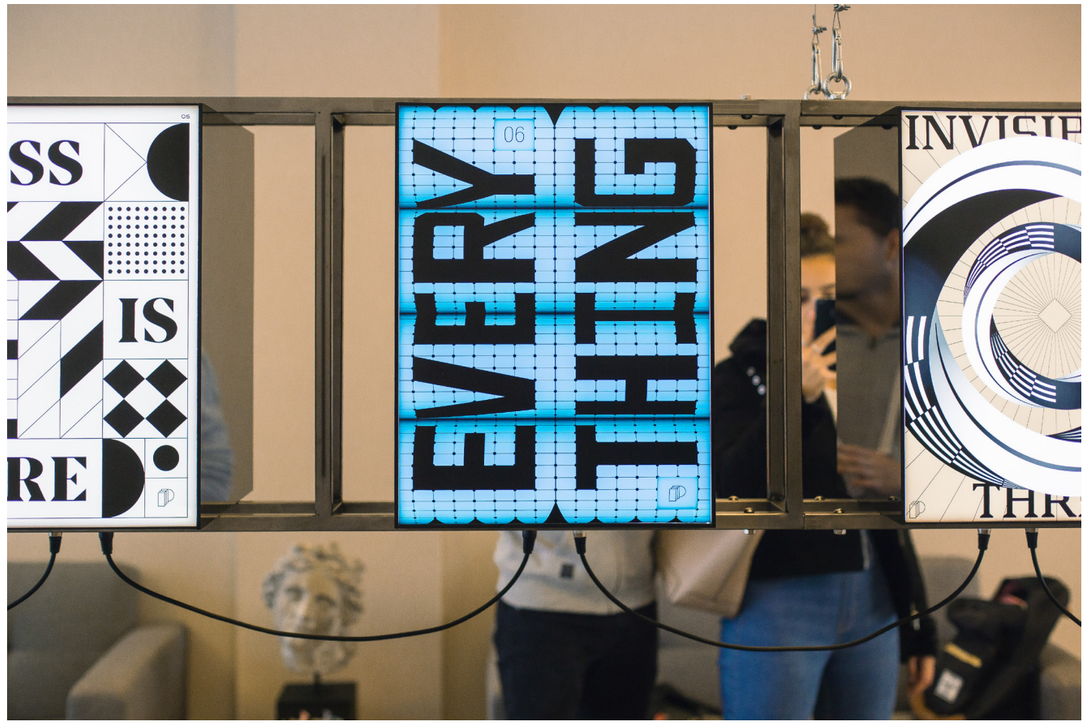


Fig. 109 – Post-print exhibition. Photography by Inês Leal.

Fig. 110 – Post-print exhibition. Photography by Inês Leal.

Fig. 111 – Post-print exhibition. Photography by Inês Leal.

Fig. 112 – Post-print exhibition. Photography by Inês Leal.

Fig. 113 – Post-print exhibition. Photography by Inês Leal.

Fig. 114 – Post-print exhibition. Photography by Inês Leal.

Fig. 115 – Post-print exhibition. Photography by Inês Leal.

Fig. 116 – Post-print exhibition. Photography by Inês Leal.

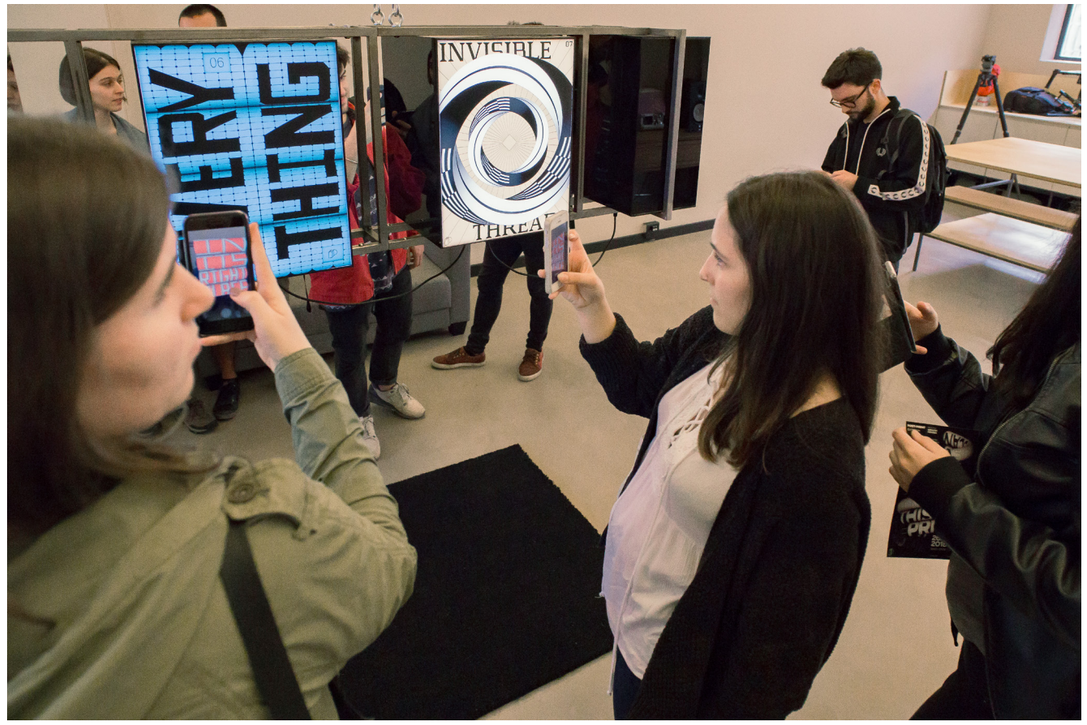


Fig. 117 – Post-print exhibition. Photography by Inês Leal.

Fig. 118 – Post-print exhibition. Photography by Inês Leal.

Fig. 119 – Post-print exhibition. Photography by Inês Leal.

Fig. 120 – Post-print exhibition. Photography by Inês Leal.

Fig. 121 – Post-print exhibition. Photography by Inês Leal.

4.10. PORTO DESIGN BIENNALE

Post-print was in the *Porto Design Biennale*, integrating the Millennials exhibition, focused on the designs and work processes of the millennials designers. The exhibition was hosted by *Galeria Municipal do Porto* (Fig. 112) from September 19 to October 17.

Fig. 122 – Galeria Municipal do Porto. Photography by Inês d'Orey.

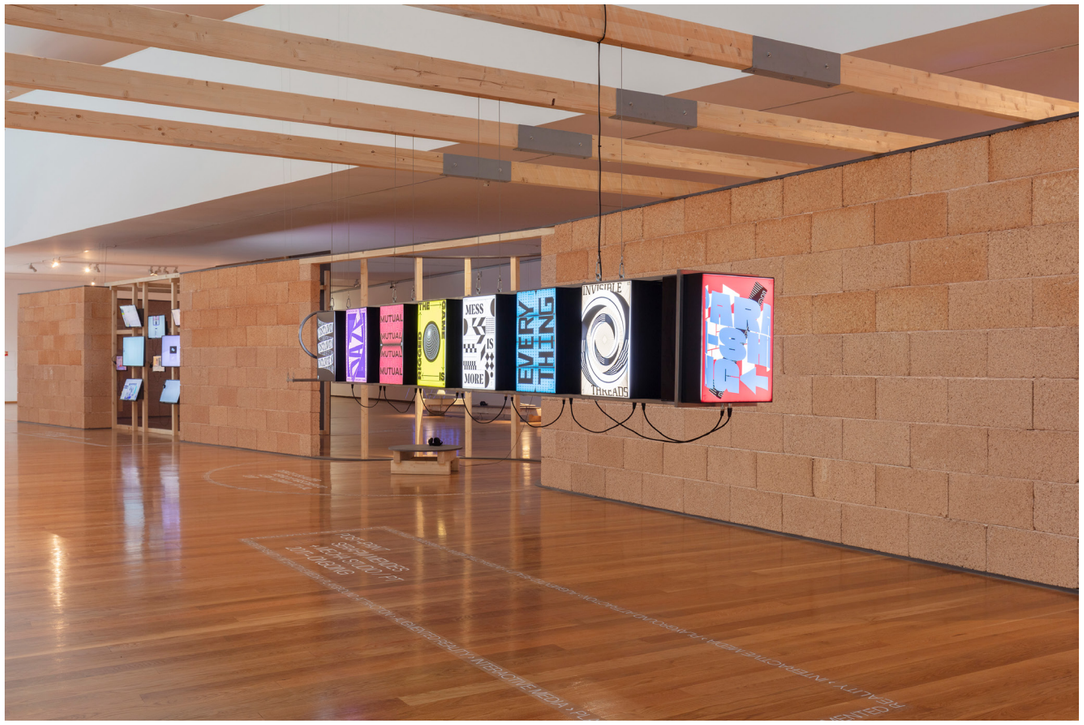


Fig. 123 – Post-print at the Millenials exhibition (Porto Design Biennale). Photography by Inês d'Orey.

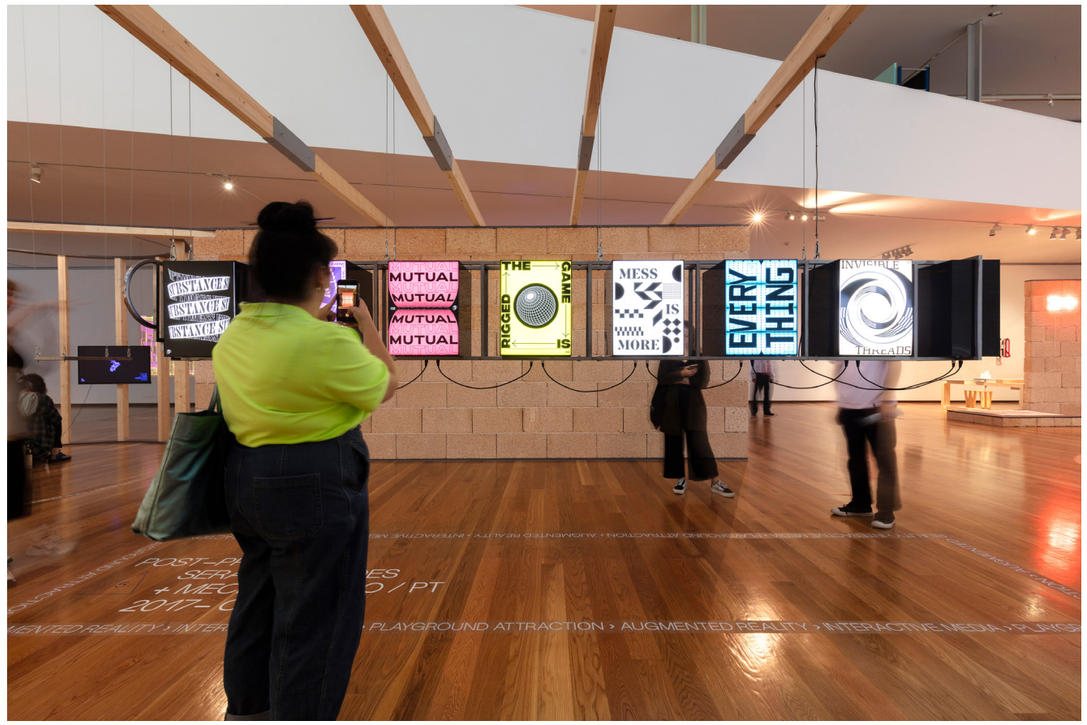


Fig. 124 – Post-print at the Millenials exhibition (Porto Design Biennale). Photography by Inês d'Orey.

Fig. 125 – Post-print at the Millenials exhibition (Porto Design Biennale). Photography by Renato Cruz Santos.

5. DERIVATIVE AR PROJECTS

This chapter features various AR projects that originated by the promotion of the *Post-print* project. Some of them include experiences created with Software as a Service platforms mentioned earlier – such as Layar and Artivive – while others feature custom AR apps. Most of these projects were done during this project and writing up and in some cases helped the understanding of the tools due to necessities that weren't met before, and even allowed the discovery of new possibilities through collaboration with experienced developers.

5.1. SARGAÇODARTE

Augmented reality poster (Fig. 126) for Sargaçodarte, an art fair. The experience is enabled through Layar. The animated video is placed on top of the static printed image (Fig. 127). The tracking quality was not optimal but it was acceptable if the device was not moving. The experience was only available for the duration of the trial (one month). For small scale projects such as this, developing a custom app might not be justified. Instead, opting for solutions like Layar or similar may help with ease of execution and reduced costs.

Fig. 126 – Sargaçodarte poster.

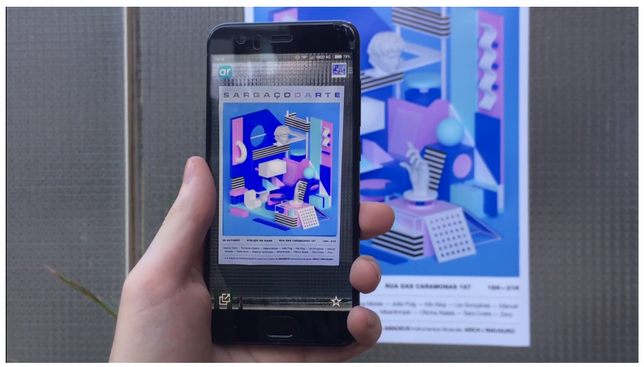


Fig. 127 – AR video overlay experiment using Layar. Full video at *vimeo.com/236453687*

5.2. SURFORMA AR POSTERS

AR poster design and custom app development for Surforma, a company by Sonae Indústria. The project was done in collaboration with This is Pacifica, who designed the brand's visual identity. The Surforma app was also developed using *Unity* and *Vuforia* featuring a structure close to the first version of the UI for *Post-print*, which included a separate menu and camera feed with no video recording.
The Surforma app was launched before *Post-print*, and it served as learning ground for app submission in both stores. The first version submitted to *App Store* was rejected by the reviewing team because it did not have any information besides the camera. By gaining this experience, I avoided facing this problem when publishing *Post-print* at a later time.
The posters included animated visual elements that represented the materials sold by the company, placed in 3D space through AR.
The app was later made unavailable so the content cannot be accessed at the time being. A video presentation made by *This is Pacifica*, includes the AR experiences and is available at https://vimeo.com/288135850

Fig. 128 – Surforma AR project. Photography by Nuno Moreira.

Fig. 129 – Surforma AR project. Photography by Nuno Moreira.

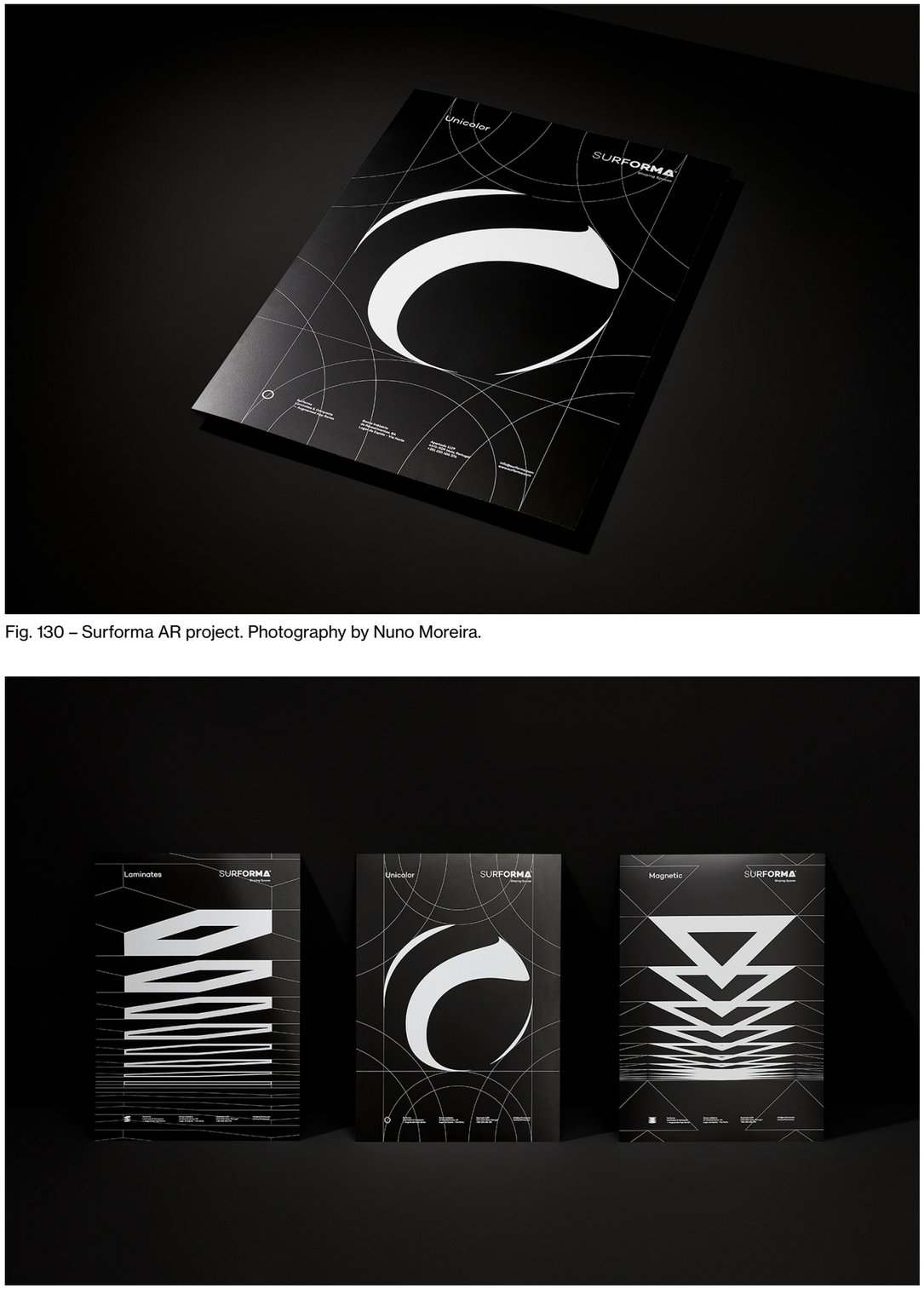


Fig. 130 – Surforma AR project. Photography by Nuno Moreira.

Fig. 131 – Surforma AR project. Photography by Nuno Moreira.

Fig. 132 – Surforma AR project. Photography by Nuno Moreira.

Fig. 133 – Surforma AR project. Photography by Nuno Moreira.

5.3. AGENDA 2020™

Agenda 2020™ by the London-based graphic design studio OMSE and type foundry OMSETYPE was an augmented reality exhibition directly inspired by Post-print, both conceptually and aesthetically. The UK-based studio invited me to take part in content creation for the exhibition that took place in July 27, 2018 at Hoxton Arches.

The exhibition aimed to promote the studio's new variable typeface Agenda in a series of AR experiences. This project demonstrates some of the potentialities enabled by the collaboration of designers and developers.

By merging skills of professionals from both fields some of the pieces were able to take a step further and include live information. The digital dashboard piece designed by me featured clocks from different locations, air quality, temperature and cryptocurrency value, all updated in real time (Fig. 134).

Fig. 134 – Digital dashboard concept AR piece. Photography by OMSETYPE.

One other piece designed by the studio showed the next train departures at the Hoxton Station (Fig. 135). After the exhibition the poster moved to the station and is still on display. This combination of live information with printed content gives a stronger purpose to the use of the medium. It proved the possibility of finding new uses for AR through collaboration.

Fig. 135 – Hoxton Station live departures AR poster. Photography by OMSETYPE.

Additionally I designed a circular experience (Fig. 136) that was placed in the ground, in the middle of the room. It was my first time working with a non rectangular target.

Fig. 136 – Circular AR experience. Photography by OMSETYPE.

My third contribution was a poster featuring stock market terminology and values (Fig. 137).

Fig. 137 – Stock market themed poster (left). Photography by OMSETYPE.

The following pages contain the target images required to see the three experiences I worked on. Use the *Agenda 2020* app, available at the *App Store* and *Play Store* to scan the images and view the AR experiences.

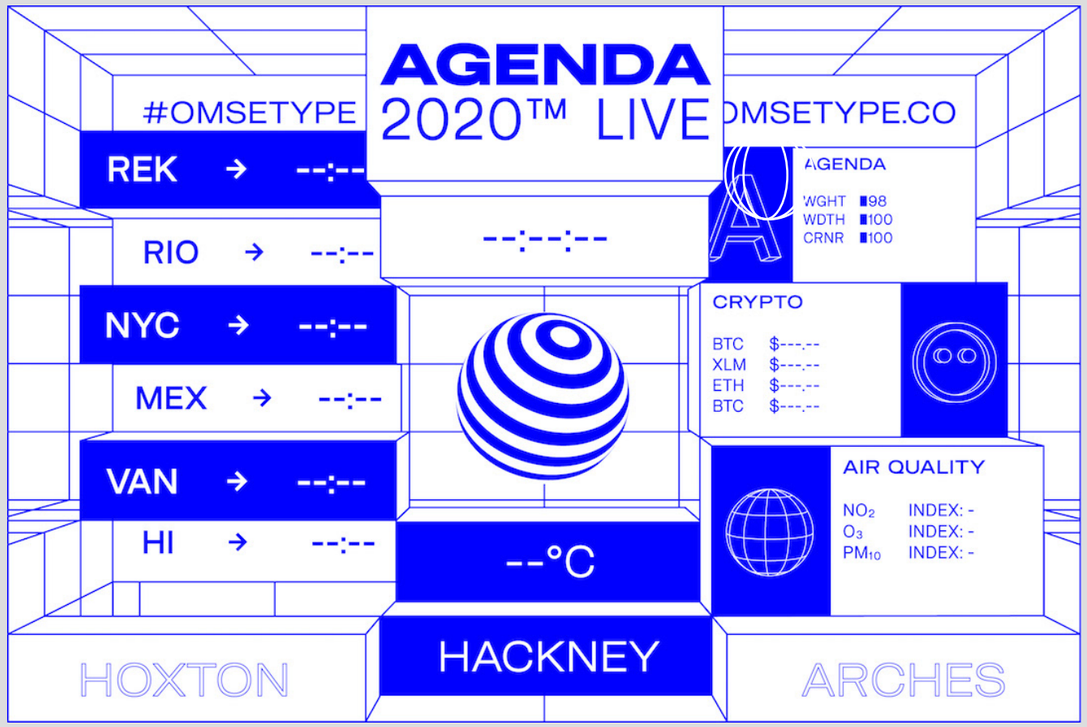


Fig. 138 – AR dashboard concept.

Experience this image in AR using the app **Agenda 2020**

Fig. 139 – Ground circular AR target.

Experience this image in AR using the app **Agenda 2020**

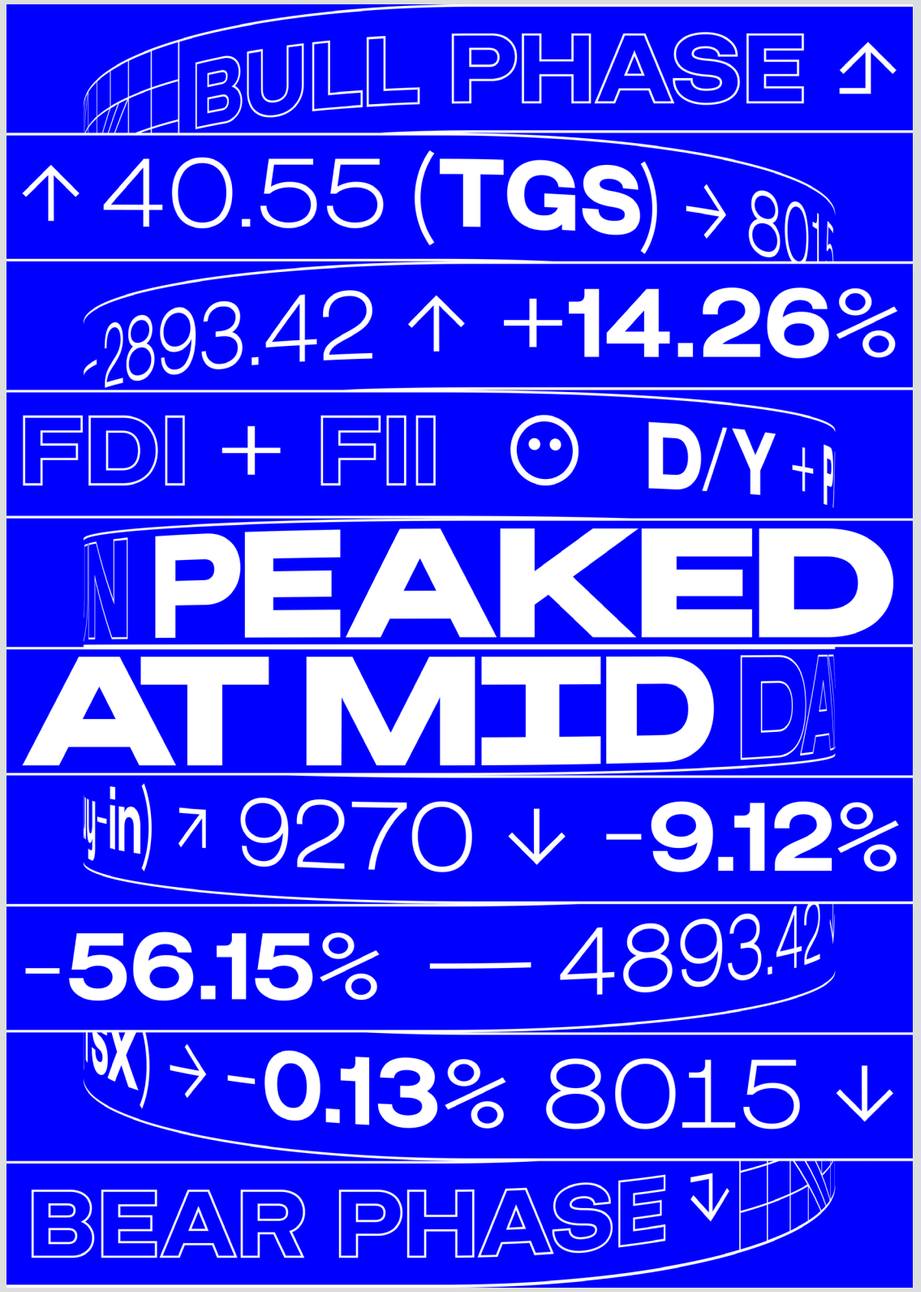


Fig. 140 – Stock market AR poster target.

Experience this image in AR using the app **Agenda 2020**

The *Agenda 2020* exhibition app (Fig. 141) was developed by Oliver Ellmers, a multidisciplinary design technologist, technical creative strategist and artist based in London. The app was developed in *Unity* using *Vuforia* in combination with *ARKit* and *ARCore*. Apart from Image Target based experiences, the app also included markerless AR, by allowing the users to hold a typographic piece in place at ground level and freely navigate around it.

Fig. 141 – Agenda 2020 app.

The app also made use of extended tracking, a feature that makes it possible to, upon detection, maintain the AR experience in place even when the target is not in the camera's field of view. This allowed the creation of a typographic tunnel that blended with the building's architecture (Fig. 142).

Fig. 142 – Extended tracking AR piece. Photography by OMSETYPE.

Lastly, the exhibition featured two cylindrical pieces that worked with the AR app, revealing a circular animation around it (Fig. 143), demonstrating yet another feature made possible with current technology.

Fig. 143 – Cylinders and AR visualization. Photography by OMSETYPE.

5.4. GRÁFICA SAÚDE SÁ: NEON PINK DIGITAL PRINTING

The illustration and animation for *Gráfica Saúde Sá*'s promotional poster (Fig. 144) for *Neon Pink Digital Printing* in collaboration with the designer Oscar Maia. For this particular project, the tool of choice was *Artivive*. It provides tracking quality seemingly as good as the one obtained with *Vuforia*. *Artivive* is close to Layar in terms of being focused on 2D content, however it offers better tracking quality at the cost of no interactivity options such as buttons or links. With *Artivive Bridge*, however, it's possible to position videos and images through the Z-axis, adding a sense of depth and parallax movement. The target must be scanned using the *Artivive* app, available for *iOS* and *Android*, in order to access the augmented content.

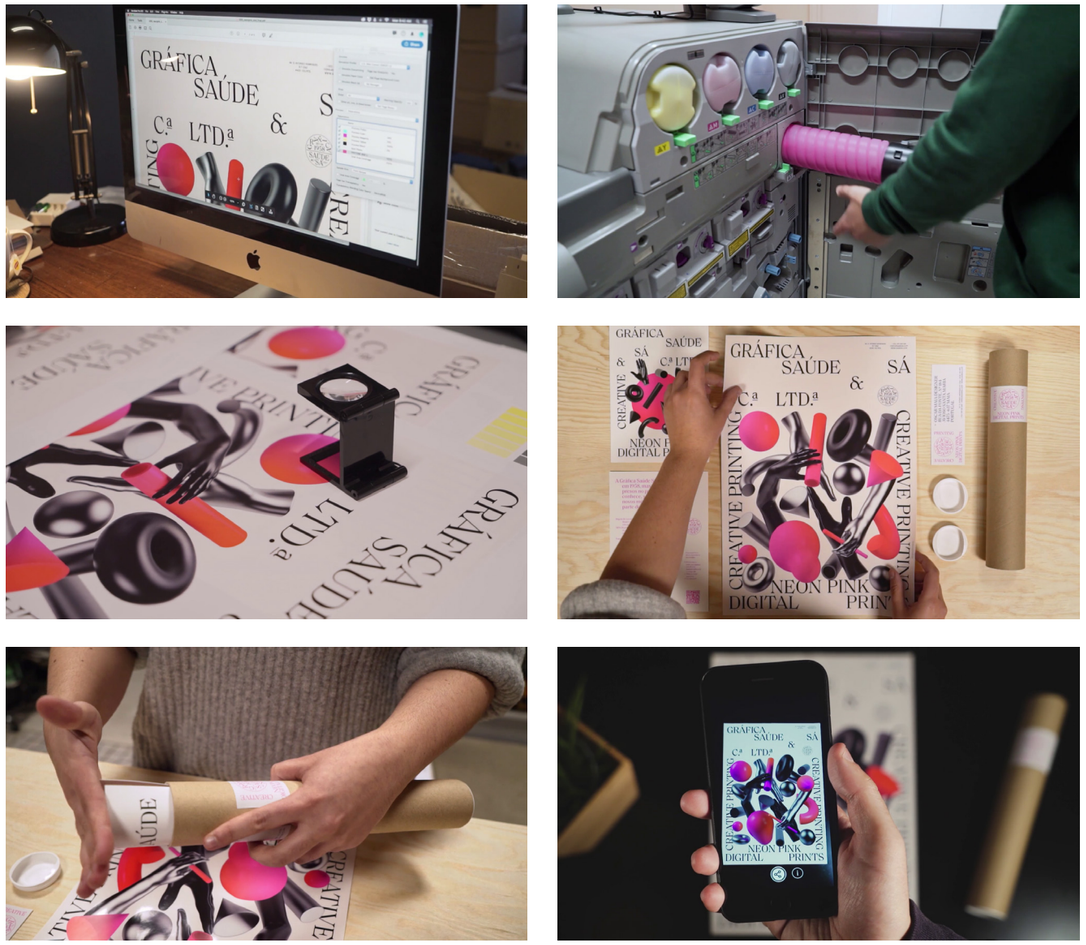


Fig. 144 – Neon Pink Digital Printing promotional video snapshots. Full video available at *vimeo.com/ 300976831*

Fig. 145 – Neon Pink AR target.

Experience this image in AR using the app **Artivive**

5.5. BIG KITCHEN

Big Kitchen (Fig. 146) is the name of an exhibition by João Miranda (Walking Fearless) and the creative platform Desisto with the aim of promoting BIG, a variable type family, in a living type specimen.

Fig. 146 – Big Kitchen presentation image.

I was invited to produce AR experiences to integrate the exhibition. Developing a custom app was considered, but since most contributors worked with 2D animations, we opted for the Artivive platform. This way, everyone could produce different videos and that provided consistency in all augmented experiences with faster execution. I produced 4 weekly calendars (Fig. 147-150) and one animated poster in collaboration with João Miranda (Fig. 151).

Fig. 147 – Week 1 Big Kichen calendar.

Experience this image in AR using the app **Artivive**

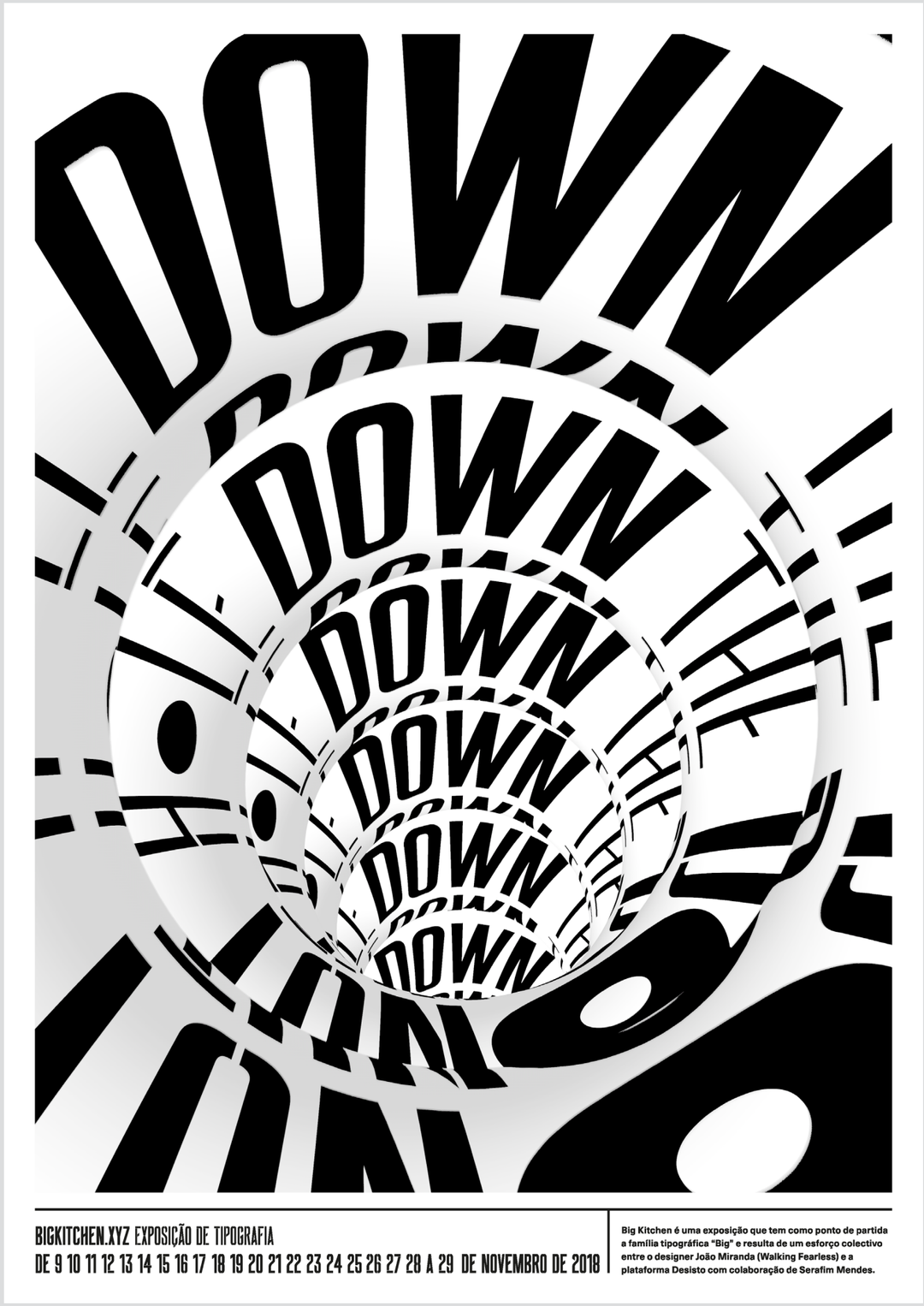


Fig. 148 – Week 2 Big Kichen calendar.

Experience this image in AR using the app **Artivive**

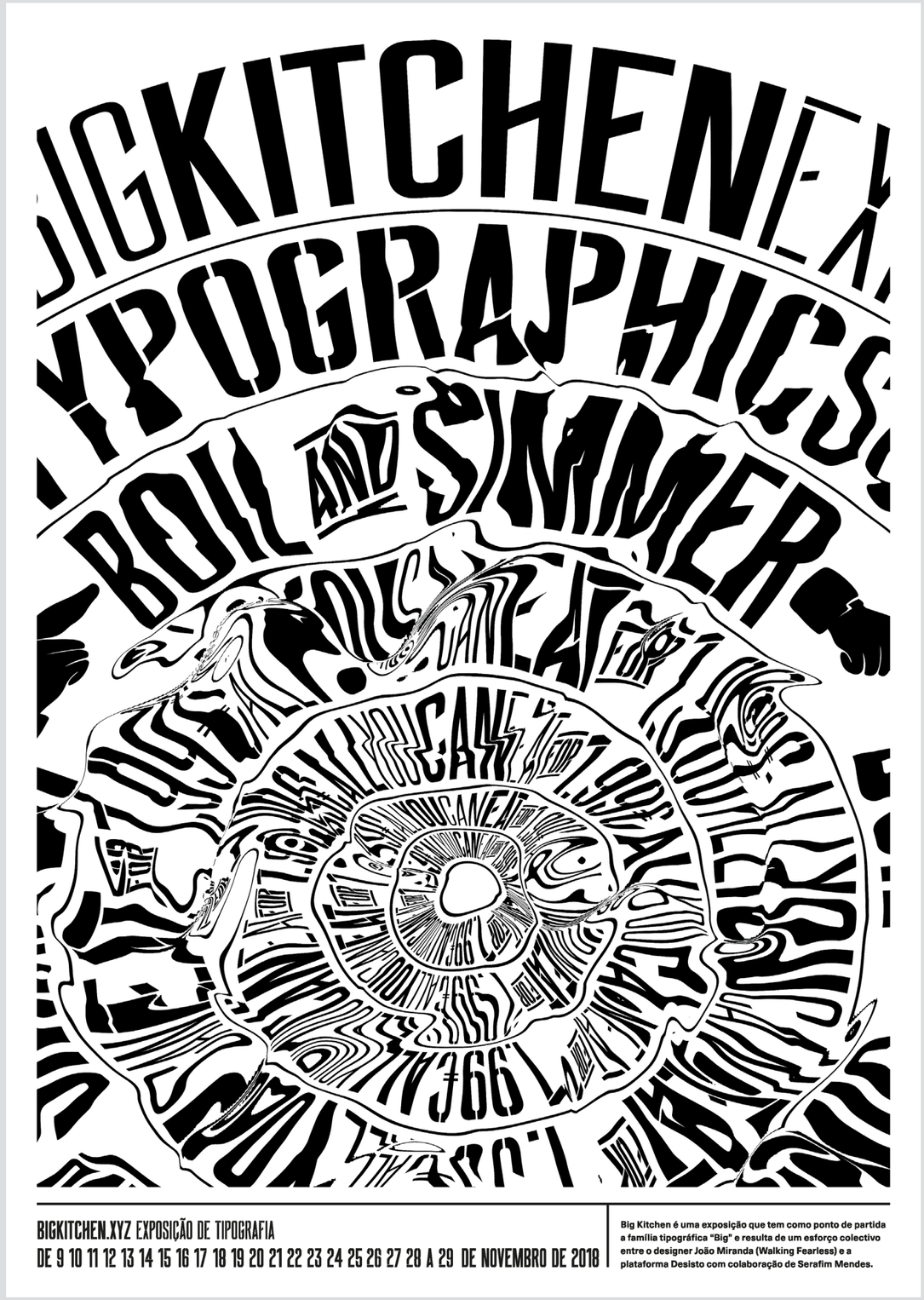


Fig. 149 – Week 3 Big Kichen calendar.

Experience this image in AR using the app **Artivive**

Fig. 150 – Week 3 Big Kichen calendar.

Experience this image in AR using the app **Artivive**

Fig. 151 – Animated poster. Collaboration with João Miranda.

Experience this image in AR using the app **Artivive**

Fig. 152 – Big Kitchen exhibition. Photography by Two Design Studio.

Fig. 153 – Big Kitchen exhibition. Photography by Two Design Studio.

Fig. 154 – Big Kitchen exhibition. Photography by Two Design Studio.

Fig. 155 – Big Kitchen exhibition. Photography by Two Design Studio.

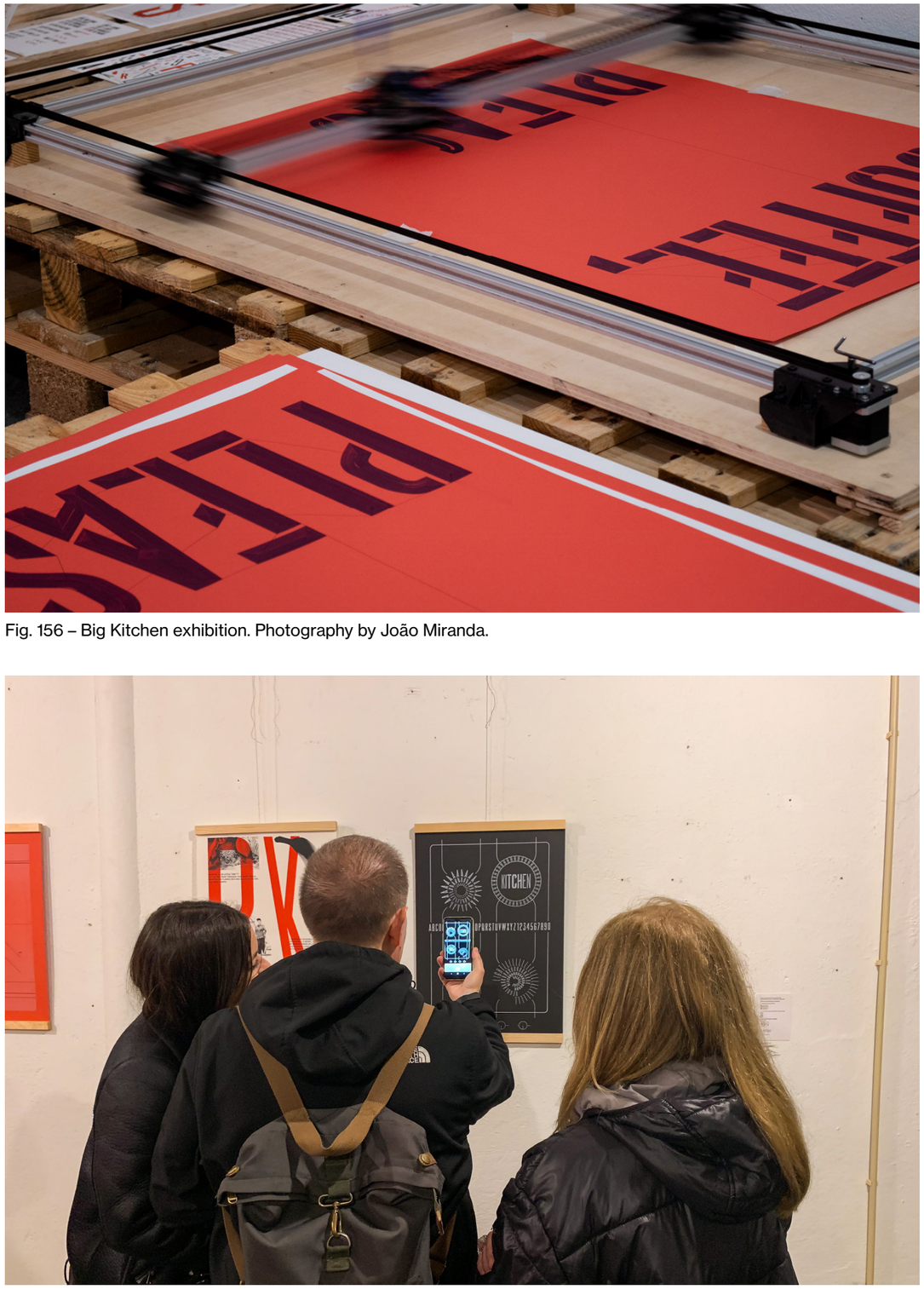


Fig. 156 – Big Kitchen exhibition. Photography by João Miranda.

Fig. 157 – Big Kitchen exhibition. Photography by João Miranda.

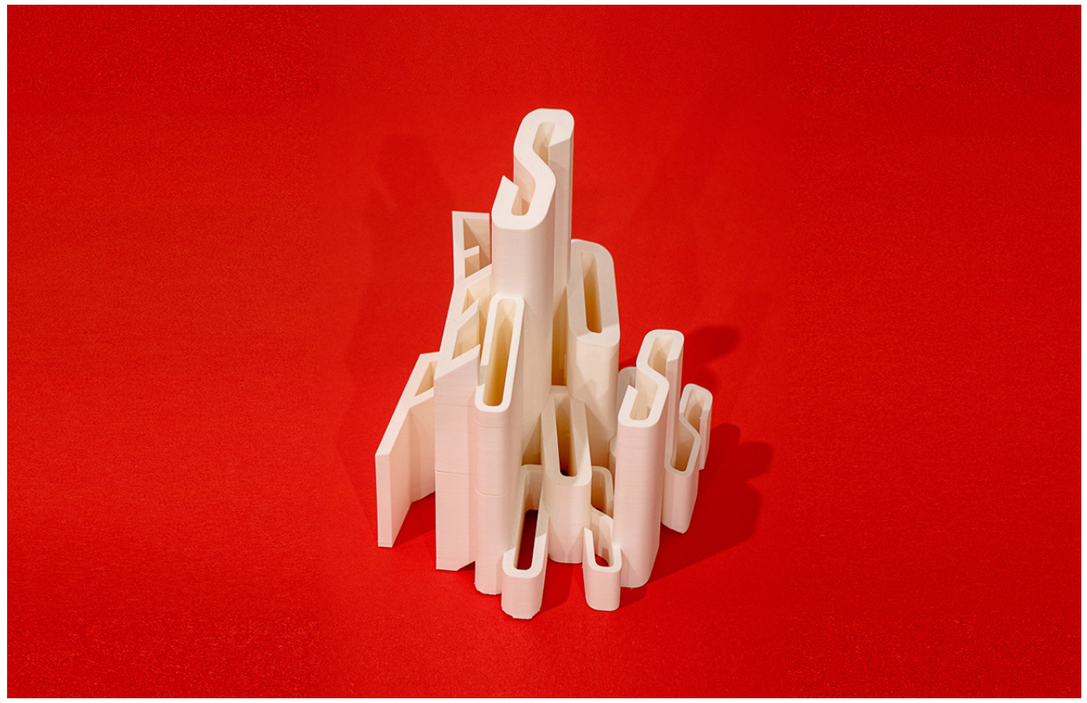


Fig. 158 – Big Kitchen exhibition. Photography by João Miranda.

Fig. 159 – Big Kitchen exhibition. Photography by João Miranda.

5.6. ESAD MATOSINHOS NEW YEAR POSTCARD

A augmented reality postcard (Fig. 160) was created for *ESAD Matosinhos* to distribute before the end of the year. The printed target features *"New Year"* and *"Ano Novo"*, which becomes *"Happy 2019"* and *"Feliz 2019"* when scanned with the app.

Fig. 160 – New year postcard AR experience snapshots.

The words were placed in a geometric composition that popped from the surface after being scanned (Fig. 161). Due to the context of this request, the AR experience was integrated in the Post-print app. The back of the postcard was designed by *esad–idea*.

Fig. 161 – ESAD new year postcard.

Experience this image in AR using the app **Post-print**

5.7. SOLAR CORONA / LIGHTNING ONE

The Lightning One (LP) cover design (Fig. 162) for Solar Corona, a fast-paced space-rock band. The artwork attempts to blend some features of the music, like the repetition of rhythmic structures and the use of synthesized patterns. The organic and physical component of the songs - perceived on the way pace and intensity changes along with the distorted compositions - served as inspiration for the illustration and respective animation. Through the use of Artivive (Fig. 163), it was possible to include the animation in the record cover.

Fig. 162 – Lightning One vinyl record design.

Fig. 163 – Solar Corona (Lightning One).

Experience this image in AR using the app **Artivive**

5.8. FÓRUM INTERNACIONAL DE GAIA 2019

In June 2019, I was invited to design the identity for the yearly event *Fórum Internacional de Gaia 2019*. It is an arts forum that features conferences, conversations and shows of music, dance, theatre, among others. The visual identity was designed in collaboration with Diana Ferreira and art directed by Maria João Ruivo.

This year's edition was focused on poetry, more specifically the *'collaboration in Portuguese'*. The request was that the identity featured 3D typography through the use of augmented reality. Several augmented supports were designed which implied some adaptation - the main poster had to be multiplied into different formats such as mupi, several outdoors, invitation, vertical banner, among others.

This presented a new challenge, since in Post-print all posters were unique in design. Here, the main design had to be adapted to each new format, while providing enough difference in each image target in order to be recognized and tracked properly. It was particularly challenging due to the fact that the main element (a torus covered with the name *FIGaia*) had to be present in all of these versions. This led to errors in target detection and pointing to the main poster would sometimes trigger the wrong experience, such as an outdoor for instance. Our way around this was by rendering multiple toruses with varied rotations, so that the text pattern would generate recognition points in different areas. Apart from this, the main information was placed with difference in scale and positioning, to help each target become more unique.

In this project, Oliver Ellmers — a developer and design technologist specialized in AR — was responsible for the development of the application, named *Gaia RA*, to leave extra time to focus on the content creation. It was also considered safer to work this way in order to be able to solve errors or technical complications in a timely manner.

Regarding AR content, it was split into two categories. The first, named *Discover*, consisting of target based experiences, including the main promotional material (Fig. 167-169), AR poetry posters (Fig. 170-172), which showed a verse from a poem and revealed an animated version and the full poem through AR. The use of 3D sound, which changed volume according to the phone's distance from the target, was considered for these posters, but not executed due to time constraints. The second content category, named *Occupy*, allowed the users to place AR content (Fig. 173-188) on the ground, anywhere, without the need for a target (markerless AR). This provided the opportunity to populate the streets with 3D verses that could be scaled, repositioned and rotated. The knowledge gained during *Post-print* allowed for much faster and capable content creation, while also being able to prepare the assets in a temporary *Unity* project, before handing them over to the developer, which ensured everything was set up as it was meant to.

An additional AR face filter was created that allowed the users to place poem verses on their faces. This was distributed through Instagram itself since it was created using *Spark AR*, which provides easy and fast facial recognition. The filter interacted to the users touch in the screen, switching through seven different poem verses (Fig. 189-195).

The app was developed using *Vuforia* SDK, the same technology used in *Post-print*. There was an early attempt to work with *Unity*'s *AR Foundation* (*ARKit + ARCore*), which had, at that time, released a big update that included image target tracking. However, this option was discarded due to problems with the way *AR Foundation* handles targets. Unlike with *Vuforia*, the printed targets had to be assigned a specific dimension according to the real world. This means that if the main poster is printed at a 50x70cm scale, it will be assigned that scale no matter the size of the print. If we print a smaller poster, the scale of the AR content will not match, since it's defined previously at 50x70cm. The tracking stability was also inferior when compared to *Vuforia*.

Augmented eality was very helpful to bring the general population closer to poetry, using a medium that not only grabbed their attention, but also provided them with interactive experiences.

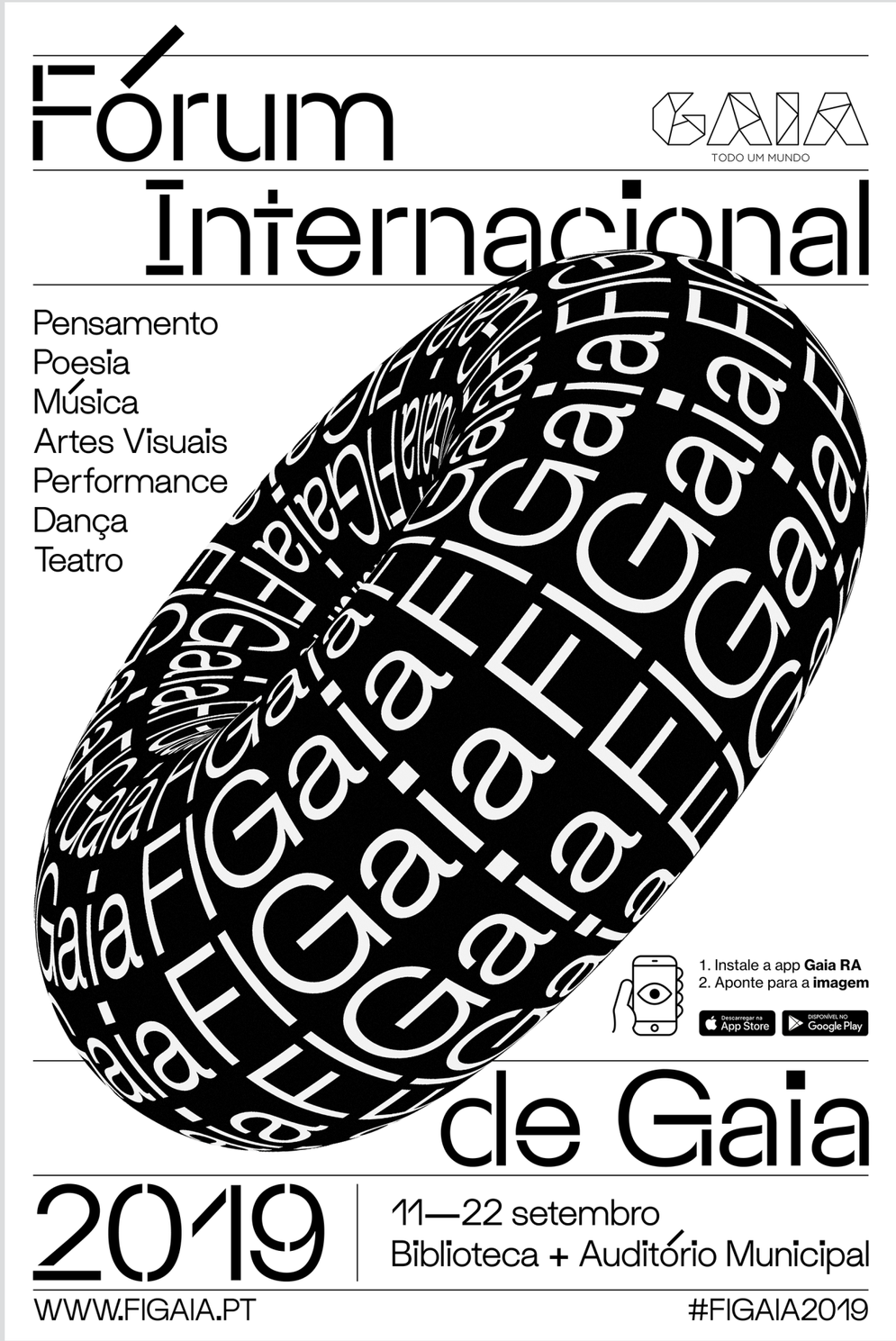


Fig. 167 – Promotional poster for FIGaia 2019.

Experience this image in AR using the app **Gaia RA**

Fig. 168 – Mini outdoor for FIGaia 2019.

Experience this image in AR using the app **Gaia RA**

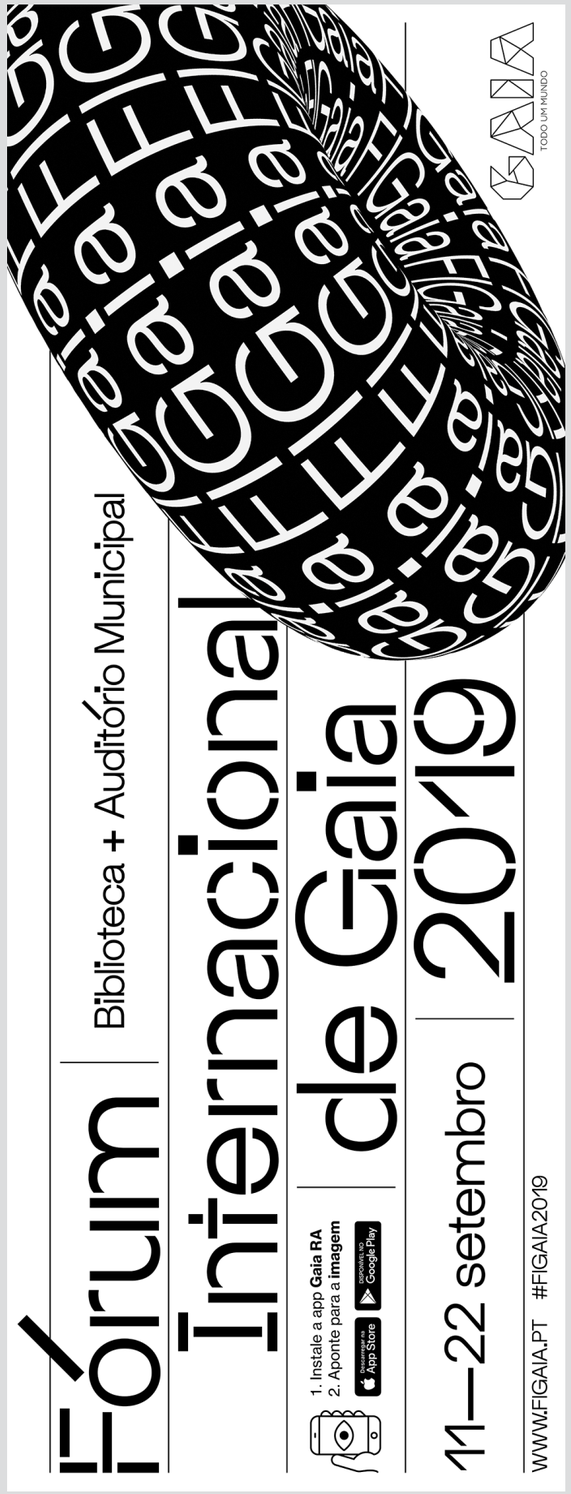


Fig. 169 – Outdoor for FIGaia 2019.

Experience this image in AR using the app **Gaia RA**

Fig. 170 – Língua de Sal #01 AR poster.

Experience this image in AR using the app **Gaia RA**

Fig. 171 – Língua de Sal #02 AR poster.

Experience this image in AR using the app **Gaia RA**

Fig. 172 – Língua de Sal #03 AR poster.

Experience this image in AR using the app **Gaia RA**

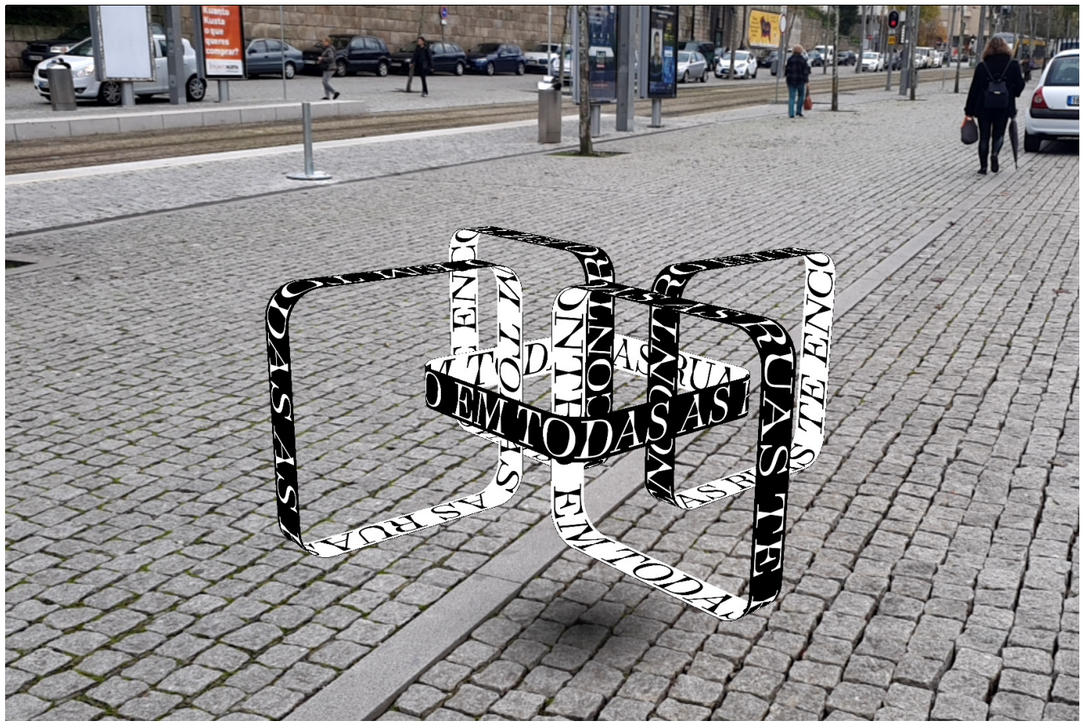


Fig. 173 – 3D poem verse using markerless AR.

Fig. 174 – 3D poem verse using markerless AR.

Fig. 175 – 3D poem verse using markerless AR.

Fig. 176 – 3D poem verse using markerless AR.

Fig. 177 – 3D poem verse using markerless AR.

Fig. 178 – 3D poem verse using markerless AR.

Fig. 179 – 3D poem verse using markerless AR.

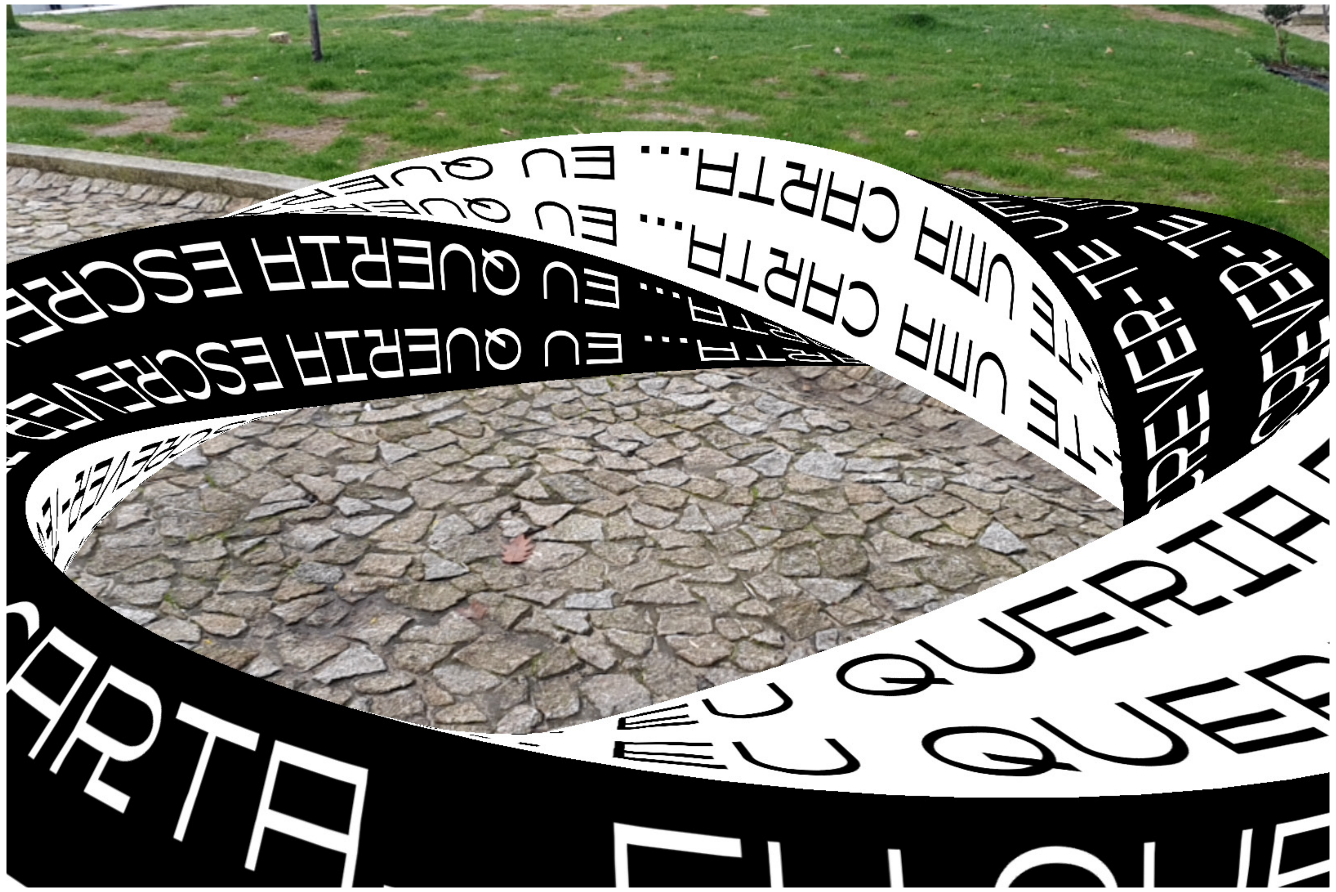


Fig. 180 – 3D poem verse using markerless AR.

Fig. 181 – 3D poem verse using markerless AR.

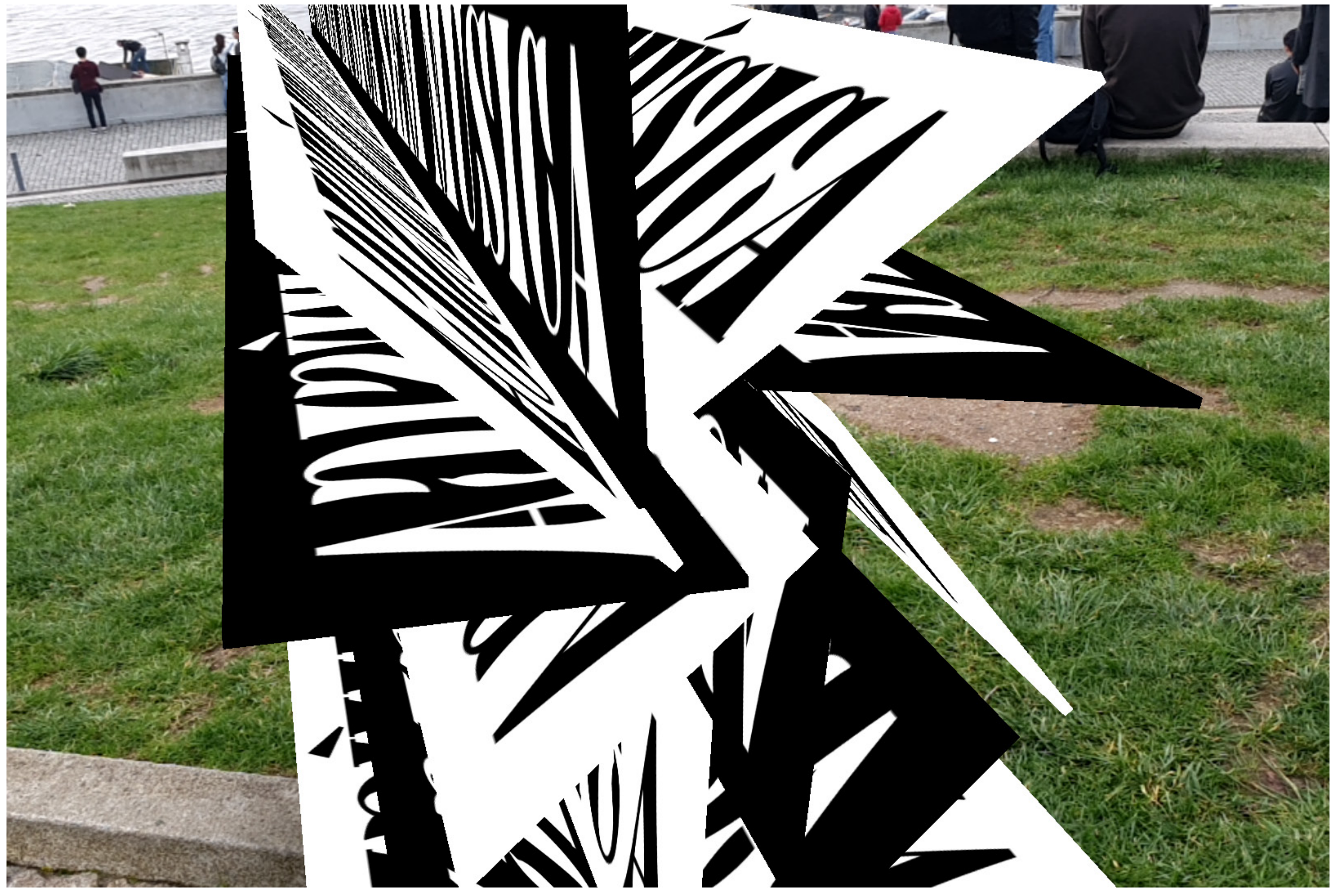


Fig. 182– 3D poem verse using markerless AR.

Fig. 183 – 3D poem verse using markerless AR.

Fig. 184 – 3D poem verse using markerless AR.

Fig. 185 – 3D poem verse using markerless AR.

Fig. 186 – 3D poem verse using markerless AR.

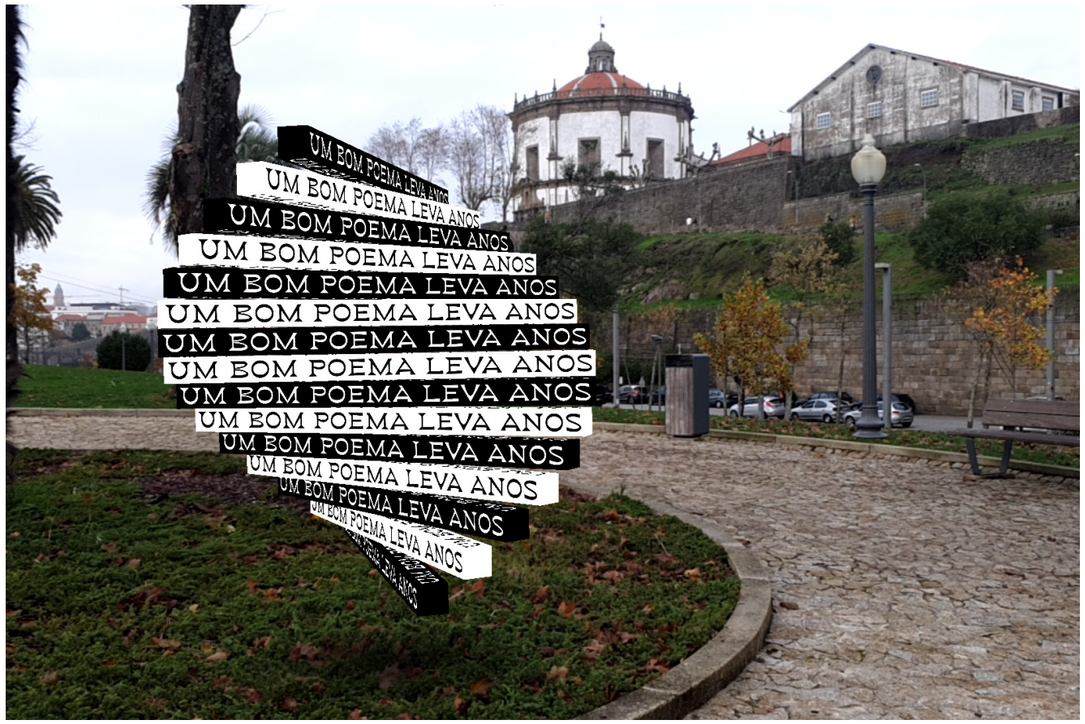


Fig. 187 – 3D poem verse using markerless AR.

Fig. 188 – 3D poem verse using markerless AR.

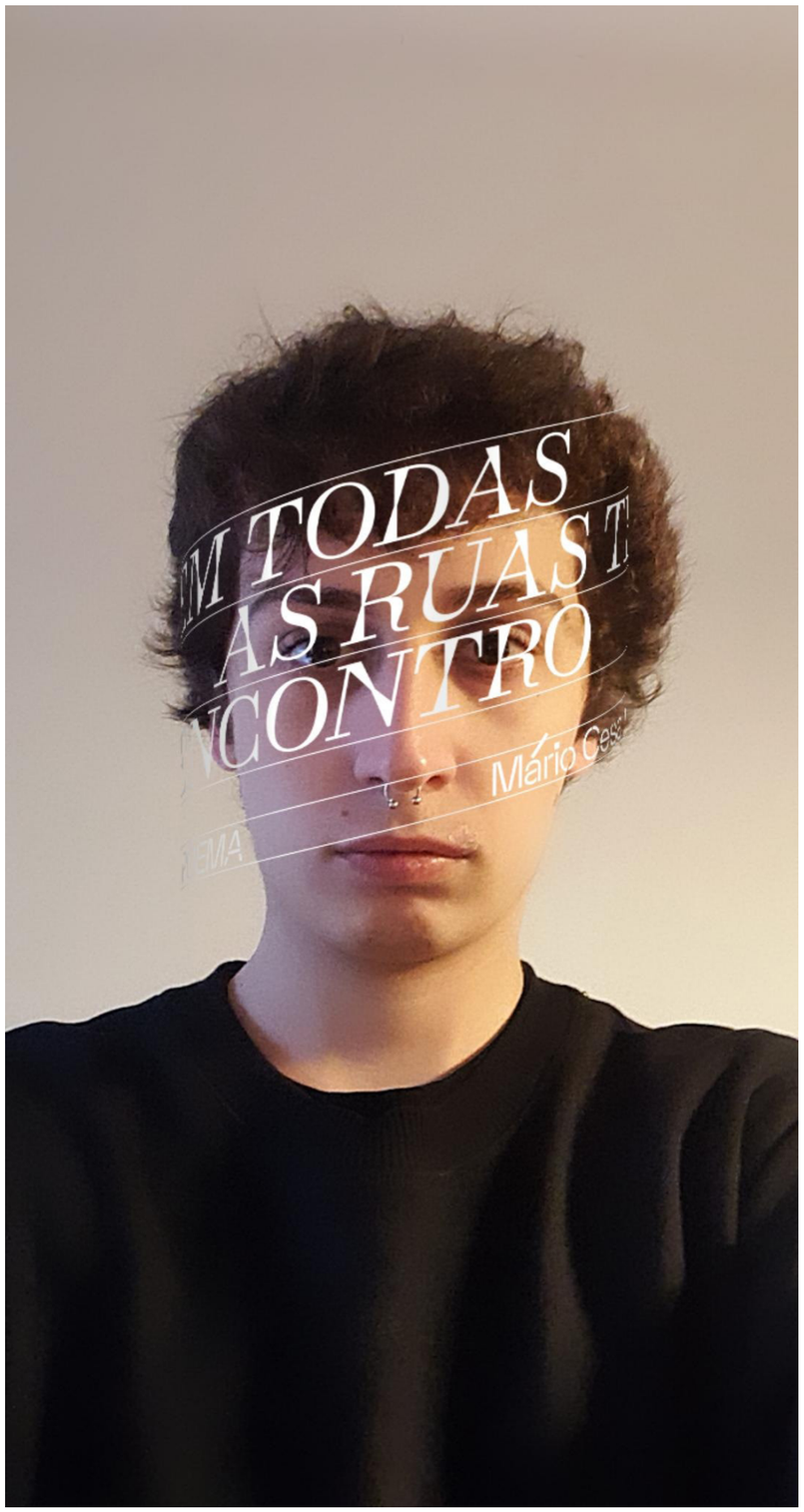


Fig. 189 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

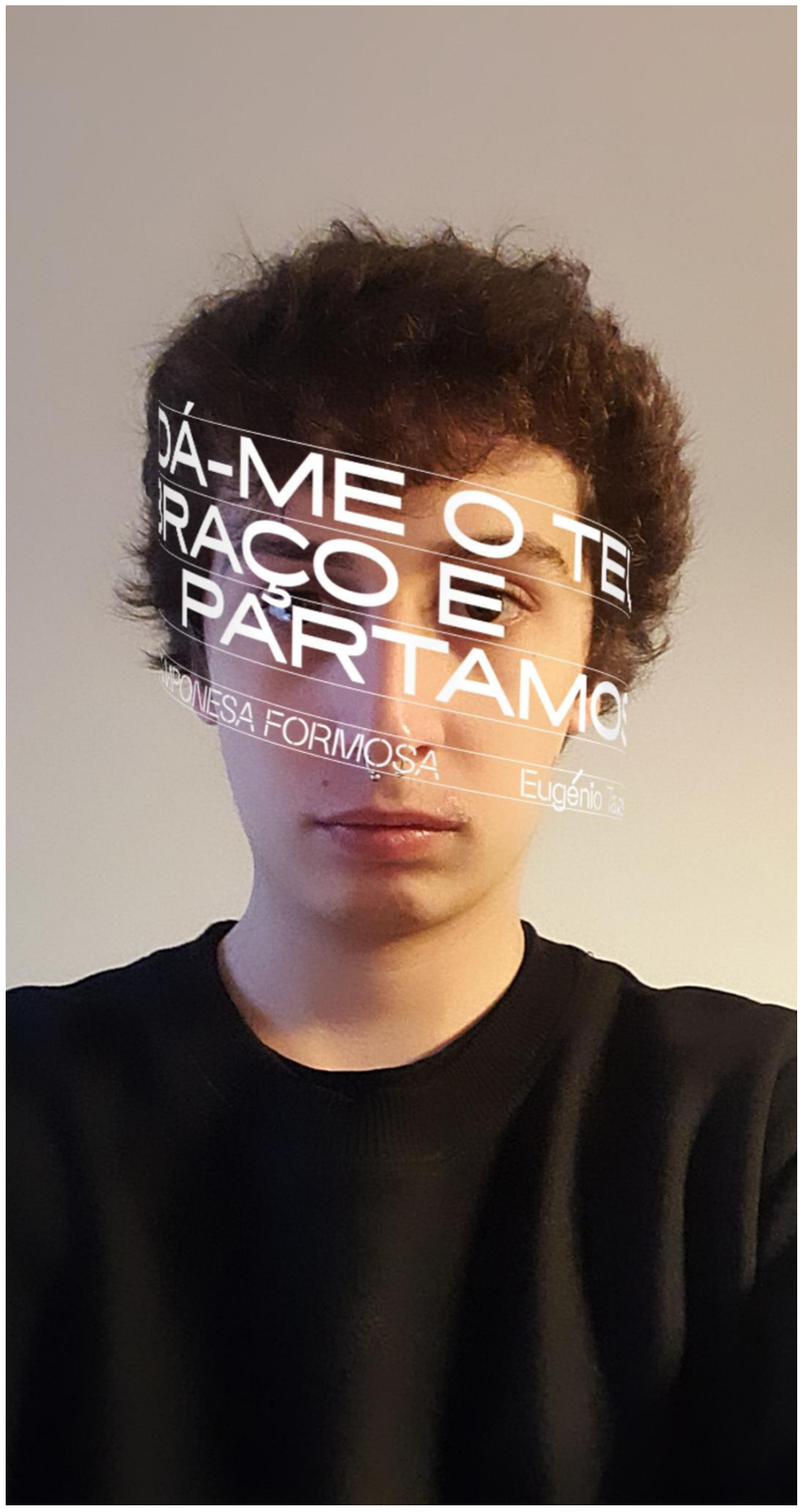


Fig. 190 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

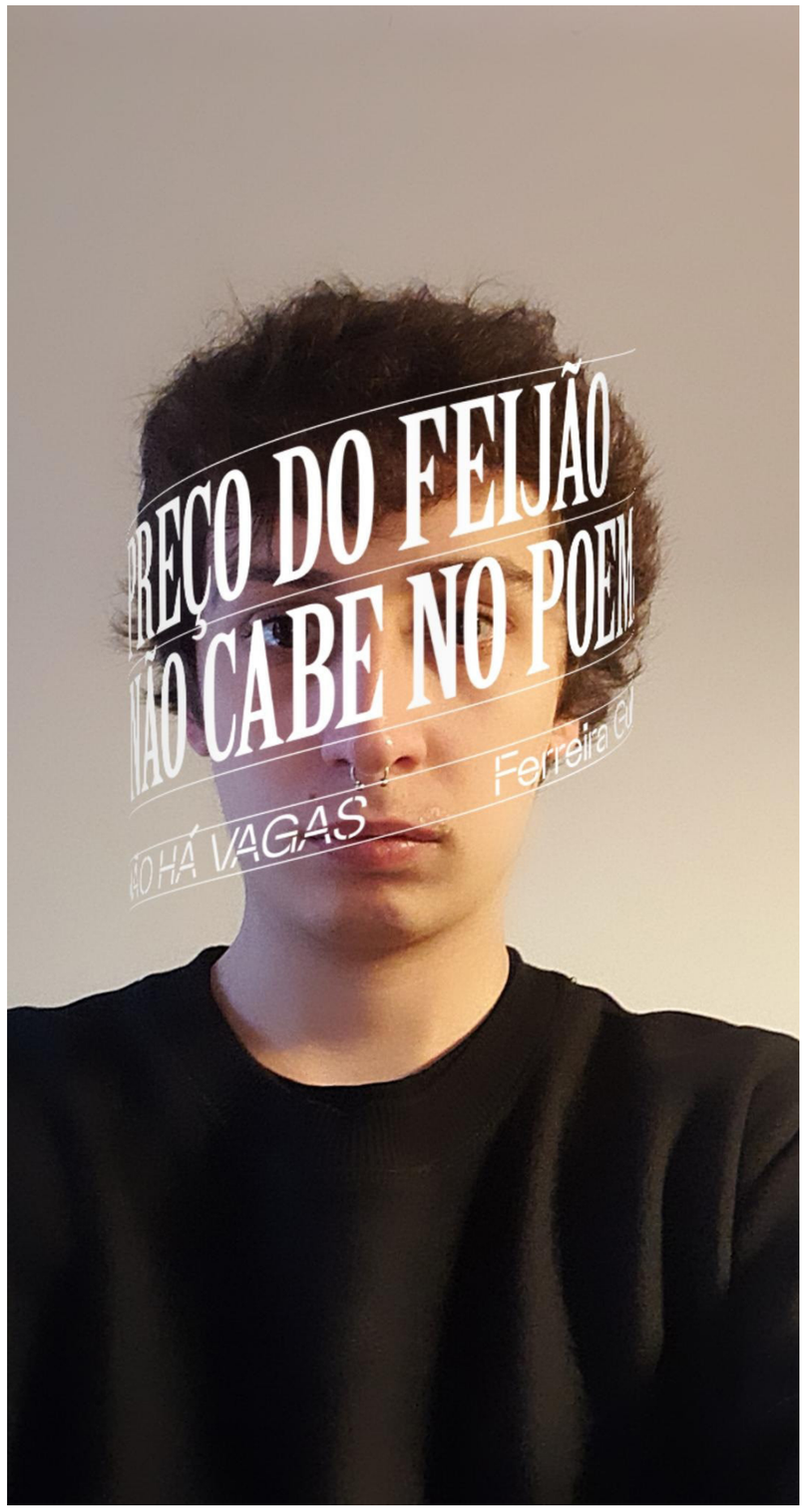


Fig. 191 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

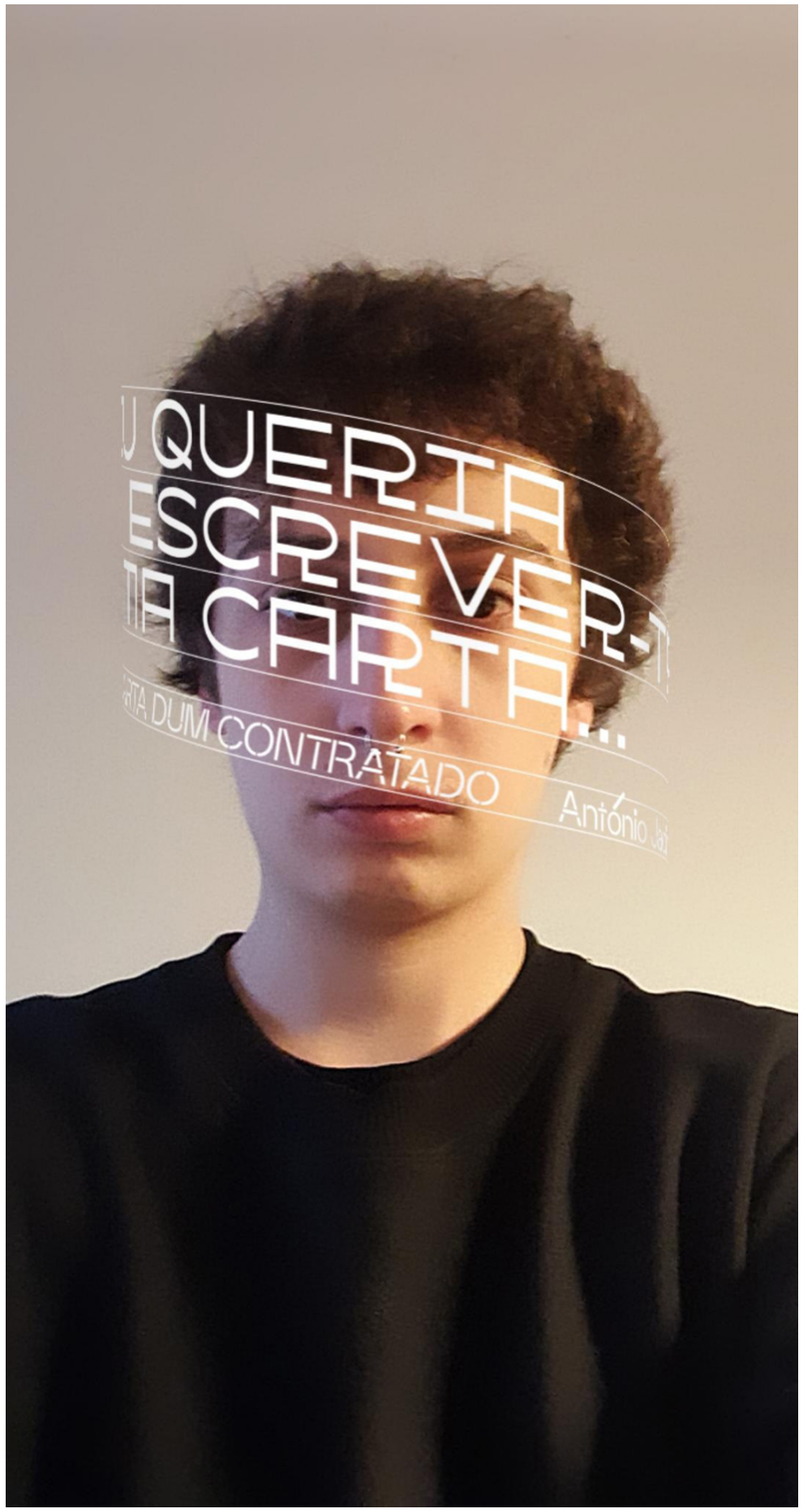


Fig. 192 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

Fig. 193 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

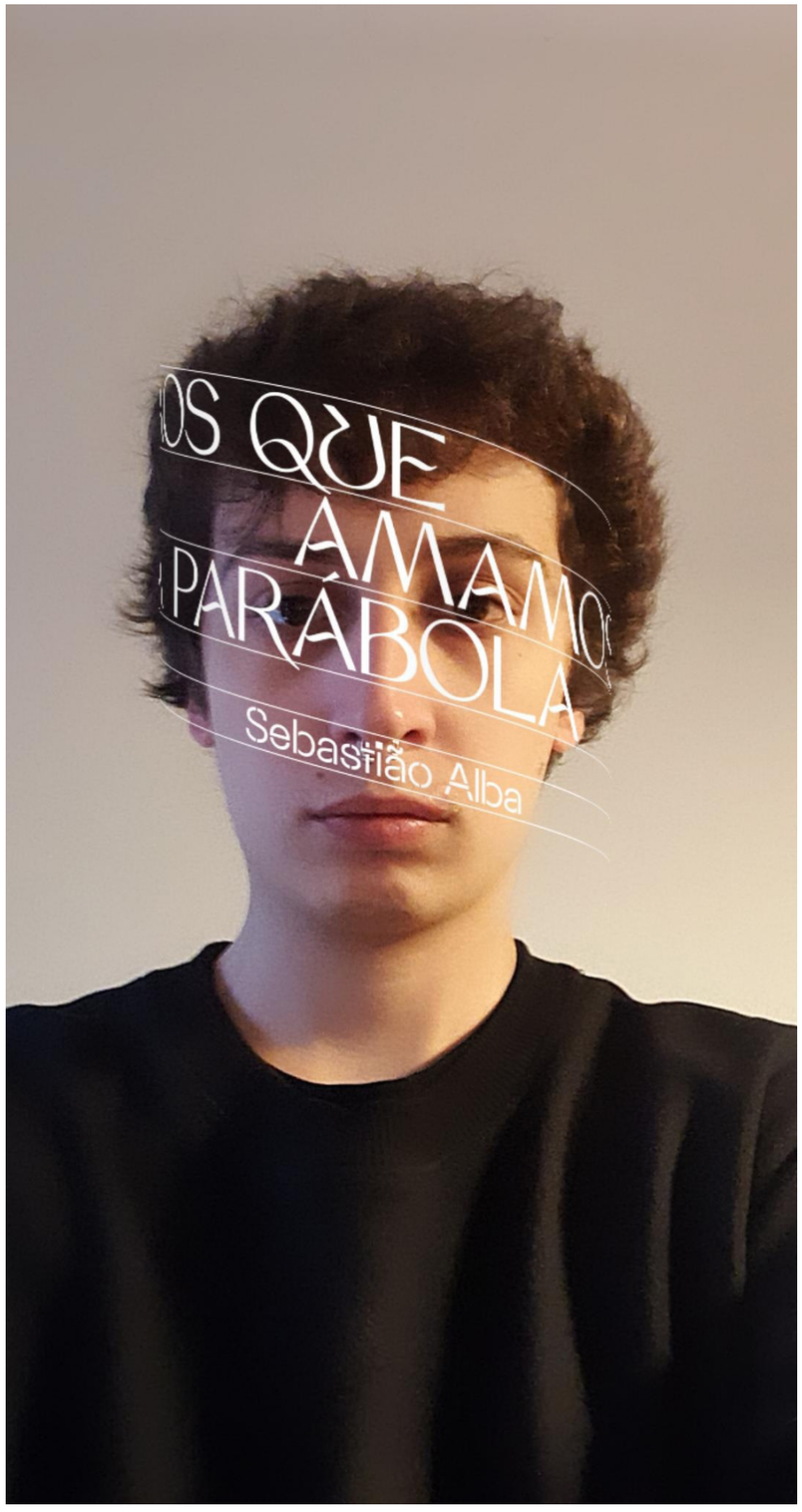


Fig. 194 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

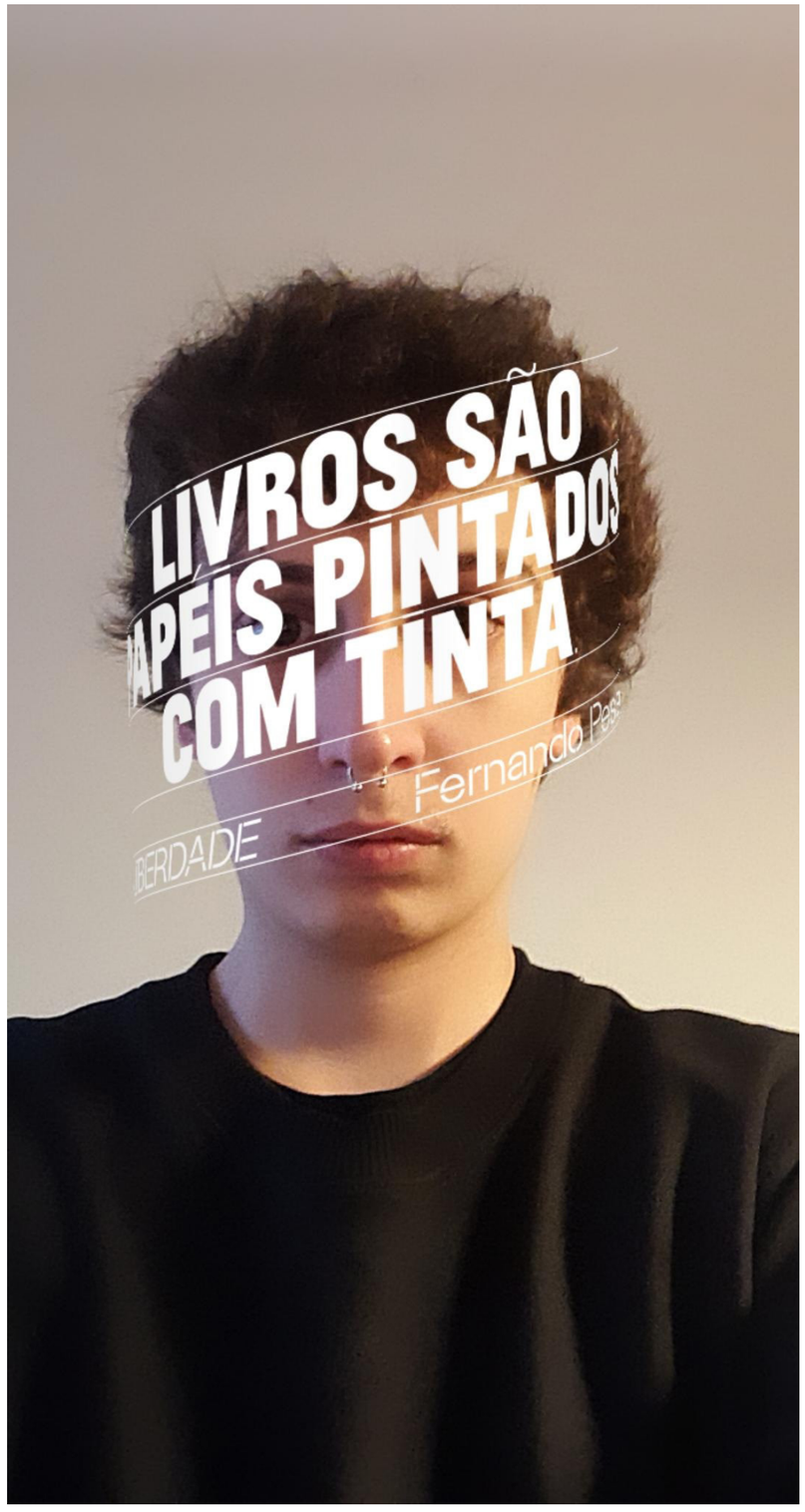


Fig. 195 – Instagram AR face filter for FIGaia 2019. Available at *instagram.com/figaia2019*

Fig. 196 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 197 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 198 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 199 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 200 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 201 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 202 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

Fig. 203 – Fórum Internacional de Gaia 2019. Photography by Tânia Franco.

FINAL CONSIDERATIONS

While this project was considered a successful experiment, it is important to take into account that it represents an exploration of new graphic possibilities enabled through the use of the augmented reality medium. It does not delve too deeply into technological aspects and complex interactions. This provides room for further exploration and development which will requires deeper technical knowledge. By its completion I have learned how to design and optimize content for AR experimenting new interactions and functionalities and discovering how to make use of this content for useful and meaningful experiences, such as the digital dashboard concept (*Agenda 2020* project in chapter 5) created in partnership with *OMSETYPE*, featuring information that was retrieved online and updated in real-time.

In *AIGA Eye On Design*'s blog post *A New Poster Movement* by Luc Benyon (2016) it is claimed that *"graphic artists (...) are teaming up with animators and bringing their combined experiences together to create a seductive new form of communication—the moving poster."* While this may be true, it has also become more common nowadays for a designer to have at least basic animation skills. However creating AR experiences may require skills that are even less common than animation from working with 3D content to app development and the learning curve can prove to be daunting. In these cases, collaborations become even more crucial.

In *Will Augmented Reality Last in Design Once the Hype Passes?* by Chairmane Li (2018), the author affirms that the designer will play an important rule on dictating the future of AR. Only further exploration of the medium can prove whether or not AR can be more than eye-candy, or as the author puts it *"another shiny technology that distracts"*. He also claims that:

> ***For AR to become practical and meaningful in our lives, artists and designers need to get involved, collaborate across disciplines, and explore use cases that go beyond pure entertainment. (Li, 2018)***

Even if AR opens up possibilities that could change the way we interact with the world around us by turning it into a canvas it will mean nothing without high quality, interactive, and animated content — this is where designers will play a big role in enriching the medium. During these experiences the user becomes active having more control over the content even if just by having the possibility of discovering hidden parts of the message by moving around the content, as is the case of this project augmented posters.

AR has become widespread and its development more accessible with the release of *ARKit* and *ARCore* making it possible to develop apps for free, resulting in content accessible to a wider audience. However, the tools to create it are far from optimized for a designer's workflow, which prevents more people from trying them. Either new tools have to be developed, or there must be an integration or bridge from designer's tools to this medium. *Adobe* has launched *Adobe Aero*, which allows the creation of high quality, polished AR experiences without even looking at code. The release of this new tool includes updates to other softwares such as *Adobe Dimension* and *Adobe Photoshop*, turning them AR-ready. These new tools and their workflows and ease to use may largely influence the future of AR and its content. *Aero* is in early stages and is currently only available for *OSX* and *iOS*, which restricts its accessibility to a smaller audience, but *Adobe* plans to bring it to more platforms.

One of the current drawbacks of the medium comes with the use of individual apps for each project, which is not optimal for users who don't often install new apps. Even with services like *Artivive*, *Augment* or *ZapWorks*, it requires less but still multiple apps. Removing that middle step or even developing a universal AR format that could be read from say a native smartphone app would make AR experiences even more accessible. An alternative to multiple apps could be the use of web-based experiences with *AR.js*, a Javascript framework based on *ARtoolkit* among other packages by Jerome Etienne.

In the *Creative Bloq* blog post *AR.js is bringing augmented reality to the web* by Alexandra Etienne (2018), the author claims that the tool was made with the goal of turning this medium accessible to everyone. While the library is open-source, completely free and improved drastically over time — from 4 FPS on high-end phones to 60 FPS on three-year-old phones —, it was not considered viable for this project due to lack of image target detection, working only with fiducial markers. If *AR.js* continues to improve and adds that feature, it could definitely represent a good alternative that skips not only native app development but also the waiting times for app approval and distribution.

This project contributes to the field by presenting innovative ways to display content using emerging technology. Throughout the fifteen posters, it explores the third dimension that can help us create more engaging experiences for the common user. Even though creating a custom AR app might represent a steep learning curve for designers without 3D or development experience, we are starting to have tools made for creatives that are designed in a way that does not require specialized skills in this medium. *Spark AR* by *Facebook* allows everyone to create and distribute a simple *Instagram/Facebook* filter in a short period of time. It has recently added the image target tracking feature, which could be a good alternative for those who are not willing to go into app development. Since this content is set up using *Spark AR*, it actually allows the creation of interactivity without coding, through a node-based language that is intuitive and easy to understand.

Even though the project has come to an end in the academic context, *Post-print* will continue as a personal project with the aim of digging deeper in the medium through the aid of collaborations, following and adapting to the new advances in content creation tools. With the rise of softwares like *Adobe Aero* and *Spark AR*, and because we are not using extra features in the app besides content viewing and recording, it could make sense to eventually move *Post-print* to such platforms and drop the custom app, as long as they provide enough flexibility and options in content creation and distribution.

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POST-PRINT
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