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Abstract: VXR technology has seen significant growth in recent years across all commercial industries and is poised to continue that trend. The graphic design industry is embracing XR as a new medium, and XR skills are in high demand within the field. Institutions of higher education must adopt XR—and particularly AR—into the graphic design curriculum to keep pace with the industry. Several barriers are slowing this curricular adoption but can be overcome.

Advances in AR technology have created an opportunity for its use as both a pedagogical tool and a creative medium. Integrating AR with traditional graphic design elements and principles will improve the learning process and outcomes of design students while elevating the design industry as a whole.

Keywords: Digital Storytelling, Virtual Cultural Heritage, Virtual Museums, Interactive Storytelling, Qualitative User Experience

I. EXTENDED REALITY IN THE GRAPHIC DESIGN INDUSTRY

The graphic design industry is rapidly embracing digital and interactive technologies as essential skillsets. According to AIGA's 2021 Design POV research report, 42% of the more than 5,000 designers surveyed believe graphic design will be increasingly digital, mobile, and interactive; and 38% believe AR/VR technology will have a significant impact on the profession in the near future (AIGA, 2021, p. 6). Thus, it is critical for educational institutions to prepare students entering the workforce with the appropriate digital skills, so that they can adapt to a vastly changing world and achieve long- term success. This is particularly relevant for industries like graphic design, where educators and scholars must now ask: "How do I adapt my skill to a virtual world?" The answer for the graphic design field lies in extended reality, and particularly in augmented reality, which enables us to overlay virtual information and objects in the real world. Higher education investment in augmented reality will benefit graphic design students in both their broader learning process and their practical skillset.

Extended reality (XR) refers to a broad range of technological forms and functions which allow for virtual and partially virtual experiences. Included in the XR technologies are virtual reality, augmented reality, and mixed reality. Virtual reality (VR) supersedes the natural experience by replacing one's actual sensual perceptions with computer-generated images, sounds, and more. Augmented Reality (AR) refers to overlaying digitally-created sensory aspects onto a moving or still image of one's actual physical surroundings. Like AR, Mixed Reality (MR) combines physical and virtual elements together but also allows for interaction between the physical and virtual objects via occlusion, where the virtual object may appear to move behind or within physical objects (Kipper and Rampolla, 2013, p. 1).

In all industries, longevity depends upon adapting to changing technological advancements. The last few years especially have brought extensive digital technology innovation, forcing businesses to adopt transformative shifts in their practices in order to succeed. The COVID-19 global pandemic pushed us all into a contactless world in the blink of an eye. This event quashed any remaining doubts among businesses still teetering on the edge of the decision on whether to embrace the inevitably necessary digital transformation. A 2020 study done by global management consulting firm McKinsey & Company showed that advancements in digital practices for business saw an average acceleration of three years over a period of just seven months.

Deloitte Digital's recent Snap Consumer AR global report states that consumers are using AR to redefine the digital experience (Deloitte Digital, 2021, p. 4). Amid the mobile usage boom, Deloitte Digital anticipates that "by 2025, nearly 75% of the global population and almost all smartphone users will be frequent AR users" (Deloitte Digital, 2021, p. 4). Ceros, a company behind the cloud-based platform that encompasses a collaborative, real-time digital canvas, compiled a list of graphic designers and studios that are pioneering and flourishing in the space between art and technology, including Zach Lieberman, DIA Studio, Gerard Mallandrich, Seas Design, and Two Much.Co (a collaboration between Benjamin Chan and

Malone Chen). As tech giants like Facebook and Apple continue to push toward AR with technologies like AR headsets and glasses (Needleman and Horwitz, 2021), it is likely that others will follow suit.

In addition to mobile AR or headset-based AR, other trends that are expected from AR in 2021 include smart glasses, avatars, 5G enhancing the AR experience, increased adoption of AR technology to enhance educational experiences, AR to reimagine theme park rides, and LiDAR technology to improve AR capabilities (REYDAR, 2021). We're now starting to see AR usage become more frequent in advertising, movie theaters, and mobile video games (Papaefstathiou, 2019), and it's already showing to be beneficial. An experimental study conducted by Mauroner, Le, and Best (2016) to determine augmented reality's impact in advertising and brand communication found that interactivity has a significant impact on brand recall, thus leading to improved cognitive processing of the brand's messaging.

> "Brand recall depends heavily on relevant consumer experiences, which usually can be achieved after the purchase. AR combines printed ads with virtual reality and has the potential to provide the consumer with product relevant experiences.

> AR can be seen as a substitute for real life product experiences" (Mauroner, Le, and Best, 2016, p. 425).

In the world of mobile apps, the potential for AR is readily apparent. While social media campaigns often use AR to offer unique filters that get users excited, there are growing opportunities for more extended interaction.

Games like Pokémon Go allow brands to offer immersive engagement — bringing a brand's impact into the user's own real-time, real-world experience. The retail and fashion industries have begun to leverage AR to allow an active shopping experience, enabling customers to project images of clothing onto their bodies and housewares into their own homes using their device's built-in camera. IKEA launched beta testing for their Studio app in April 2021, allowing customers to capture dimensions of entire rooms using iPhone LiDAR technology and then use the app's AR function to test out furniture in their homes with ease (White, 2021). Such immersive engagement will become the norm as users and customers grow to expect those opportunities for a customized experience. Tourism will likely also increasingly utilize AR in their endeavors.

Kwok and Koh (2020) posit that "tourists will continue to seek diverse travel experiences in fulfilling their hedonic motivation." Considering the impact of the COVID-19 pandemic, AR can enable the tourism industry to offer a virtual travel experience, where tourists need not physically visit the place to achieve an immersive experience using AR and VR technology (Priyakrushna, Hassan, and Ekis, 2020). Graphic designer and founder of GraphicArt-News Maria Papaefstathiou suggests several other exciting potential commercial applications of AR, including pop- up promotional offers as a customer scans a store with their phone, or 360-degree animated instructions for assembling furniture.

As people increasingly gravitate toward memorable interactive experiences, simple static visuals are growing outdated. While print media still holds an essential place for

a few demographics, the demand for print material is dropping precipitously. According to data analysis from media investment company GroupM, print advertising revenue in the United States has steadily declined every year since 2012 and is projected to decline further every year until at least 2024 (Wieser, 2019). Print media is largely environmentally unsustainable, often expensive, takes up physical space, and provides comparatively minimal interactivity which can lead to inaccessibility. Given the trend in consumer interest and the recent pandemic-fueled shift toward exclusively virtual consumer interaction, AR is poised to be the ideal technological solution for meeting consumer demand and maintaining exciting brand engagement. Graphic designers must be prepared to meet that demand and craft those digital experiences. Those designers who do invest in AR skills will be in high demand and will contribute to a new era of interactive design.

II. AUGMENTED REALITY IN THE GRAPHIC DESIGN CURRICULUM

A. The Need for and Barriers to AR in the Graphic Design Curriculum

Most graphic design curricula today require students to create projects either on their digital devices or on paper — usually mounted on foam or matboard — or sometimes both. The primary challenge with such methods is that it is difficult for students to properly visualize their end- product in a real-world setting. A student designing a billboard or wayfinding system can digitally mockup a still image, but the mockup lacks the three-dimensional interaction a user would experience. Many components must be considered, including where the product

will be placed, how people will interact with the product, what the surrounding environment will look like, how much visual clutter and noise are present, etc. These elements can and should influence a designer's font choice and text size, color selections, and general layout. Students are asked to imagine such interaction and account for it but cannot fully visualize it using the common means of printed and still digital images.

AR in the classroom would enable students to place their work in the real world and walk around it to imagine their final product more realistically in situ, empowering students to make smart design decisions right from the start and throughout the design process. Professors Jeremy Kerr and Gillian Lawson, of QUT School of Design in Australia, and Lincoln University in New Zealand, respectively, wrote about their experience utilizing AR technology with landscape design students. They praise AR's ability to connect students with the end- result implications of their designs, saying, "AR offers a new individualized learning experience, a 'burst of information' while engaging with theory and being surrounded by a site in the real world" (Kerr and Lawson, 2019). In graphic design, this is the natural evolution of the digital mockup and a vital tool in training our next generation of designers. By bringing AR into the graphic design curriculum, we not only introduce students to a valuable new skill, we also immediately put that skill to use in applying the more traditional skills encompassing the elements and principles of design.

Despite the pedagogical and commercial applications of AR technology, several barriers are stalling the adoption of AR in higher education programs. A study

conducted by Mona Alkhattabi of Al Imam Mohammad Ibn (2017, pp. 95–97) Saud Islamic University on those barriers found that despite familiarity and acceptance of AR among a majority of teachers, the primary barriers to AR adoption are perceived to be a lack of appropriate IT infrastructure, human infrastructure, IT skills, and resistance to change. A separate study done by Barroso-Osuna, Gutiérrez-Castillo, Llorente- Cejudo, and Ortiz (2019, pp. 134–135) posit that the lack of teacher training, educational experience, conceptual foundation, educational research, and institutional support were key factors presenting difficulty in adopting AR for higher education.

From a pedagogical perspective, Wu, Lee, Chang, and Liang (2013, p. 47) posit that another challenge is instructional design. Specifically, educators may struggle to determine how information surrounding AR systems and learning activities should be distributed and flowed between two realities and among various devices. In addition, Wu's group (2013, p. 47) noted that some AR systems are inflexible, making it impossible for teachers to make changes to accommodate students' needs, or to achieve instructional objectives. From a learning perspective, the group (2013, p. 47) posits that challenges stem from students' learning processes. This includes cognitive overloads from the large amounts of information and many technological devices that students use, as well as an overall lack of essential skills in spatial navigation, collaboration, problem- solving, technology manipulation, and mathematical equation (Dunleavy, Dede, and Mitchell, 2009).

B. Implementing AR in the Graphic Design Curriculum

As Wu, Lee, Chang, and Liang (2013, p. 47) suggested, "Designers of AR learning environments need to realize the gap and provide possible support to help teachers and students bridge it." Teachers must first feel well-equipped in their ability to implement AR in graphic design curricula. Institutions should offer sufficient training and certification opportunities for graphic design educators.

Some example training XR/AR/VR training courses include those offered by Circuit Stream, Curtin University, New York University, Udemy, and Coursera. Currently, there are 9 teaching resources (lesson plans, supplemental materials, and projects) on the Adobe Education Exchange platform for higher education curriculum. There are also mini-tutorials on the Adobe Aero website. There are also professional learning certificates on Adobe Education Exchange for creating augmented reality in the classroom.

With these resources in place, teachers would enter the classroom with deep knowledge and expertise, as well as a firm plan of action for guiding students on AR learning principles. Further, graphic design curricula should invest in the right AR tools. Until recently, AR was particularly challenging to grasp, as it required big teams to code a project into a cohesive, interactive story. Now, after many advances in AR technology, there are several platforms available that do not require significant coding experience and can offer the flexibility to adapt to students' varying needs.

A key tool is Adobe Aero, the AR authoring and publishing software developed by Adobe Inc. According to Cornel Hillmann

(2021, p.162), "Adobe Aero is a user-friendly approach to designing AR interactivity… [and] it can also be used to prototype AR object interaction before building a high-fidelity handheld AR prototype with Unity or Unreal." With Adobe Aero, users can practically create AR projects with a click of a button. Students can drop their visual assets into a working document and begin bringing their work to life in AR scenes using animation and/or motion graphics.

As AR is embedded in the graphic design curriculum, students must explore it as both a creative tool and a creative medium. It should be used both as a format for presenting final works and as a final work itself so that students come to appreciate its full value. In their careers as designers, some may not be actively creating AR content for consumer end-use but would still greatly benefit from the ability to use AR technology to continue visualizing the impact of their work in its final real-world environment.

Educators could challenge students to utilize AR when submitting final projects, with AR elements to show the inspiration behind or reasoning for each element. As the work is presented, their classmates and instructor could focus on the text to see the student's font selection process displayed or focus on the illustration to see a series of process images leading to the final iteration. As the immense creativity of both educators and students is applied to AR implementation in the classroom, the possibilities for its use will only grow.

III. CONCLUSION

In an era of burgeoning growth for emerging technologies, all industries are embracing a digital transformation in which AR technology plays a pivotal part. Higher educational institutions serve a vital function of preparing the next generation's workforce with the proper skill sets to achieve long-term success in their future careers. For the graphic design industry, this means those institutions must implement augmented reality into their curricula. Students will graduate with the skills to create traditional work that is better suited to its real-world environment, and the tools to create a new style of work immersing users in interactive experiences in their real-world environment. This pedagogical shift would not only improve students' learning processes and provide them with an in-demand skill set but also elevate the overall quality of their later professional design work.

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