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Augmented Reality Teaching Framework: AR Literacy for Visual Communication Design Majors

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Abstract

This chapter outlines a framework for teaching AR that enhances communication and creates engaging experiences. An overview of the history of AR is provided based on its development in the past two decades. The paper introduces a teaching model for promoting Augmented Reality literacy while using the computer as a creative medium. The main topics include enhancing traditional print and digital media, creating interactive experiences, improving accessibility for diverse audiences, and using it as a sustainable tool in design processes. The model was implemented into undergraduate Visual Communication Design computing courses. Visual literacy serves as a cornerstone in equipping students with the tools and knowledge necessary to excel in the dynamic field of AR design and development. By honing visual literacy skills, students gain the ability to comprehend, analyze, and interpret visual information, which is essential for creating meaningful AR experiences.

Keywords: Augmented Reality education, AR teaching framework, AR literacy, instructional design, visual communication design

Introduction

In recent years, Augmented Reality (AR) has been increasingly recognized as an important development in the field of media and design. As a constantly evolving medium, AR presents a unique set of challenges and opportunities for visual communication design education striving to stay at the forefront of technological innovation. However, achieving proficiency in AR requires combining new technical skills and creative thinking, which provides a new opportunity for curriculum development and instructional design strategies. University-level visual communication design education can and should invest in teaching AR skills to enable undergraduate students to achieve AR proficiency while reflecting on how visual communication design contributes to the field of AR. The Media-to-Application Framework outlined in this paper offers a strategic and comprehensive approach to teaching AR that builds students' technical abilities and helps them reflect on this emerging field and consequently keep up with emerging technologies in this rapidly evolving medium.

Augmented Reality

As AR continues to evolve, the conceptualizations and encounters associated with it have diversified, leading to various interpretations. In essence, AR is recognized as a technology that integrates virtual information into the tangible environment, augmenting a user's sensory perception through computer-generated information.

A Brief Overview of the History of Augmented Reality

The historical evolution of AR serves as the underpinning for the accessibility and emergence of diverse definitions and multiple AR experiences. The inception of AR dates back to 1901 when Frank L. Baum introduced the concept of the Character Marker (IxD, 2022). This innovation involved the creation of

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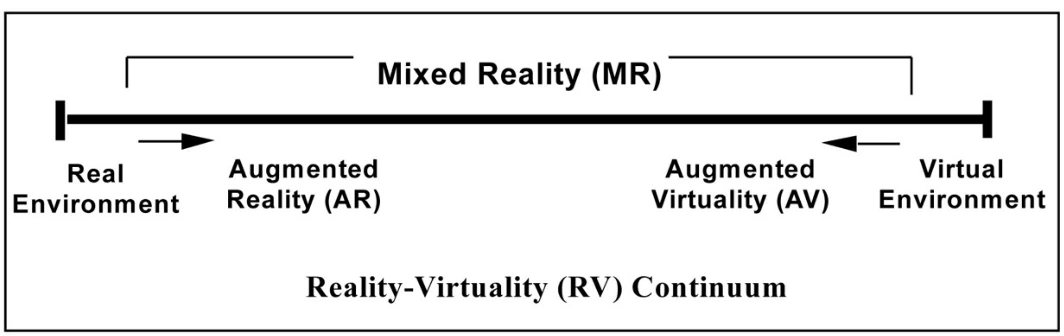
glasses, enabling users to perceive distinctive markings displayed on individuals, reflecting their character traits. For example, a "G" might appear on the forehead of a person with a good character, while an "E" could be displayed for someone embodying an evil disposition.

Following that period, the initial foray into the development of AR encounters commenced in 1957 when Heilig, an American cinematographer, delved into the concept of multisensory theater. He aspired to create an immersive environment capable of conveying images, sound, vibrations, and scents to the audience in a theatrical setting (Vertucci et al., 2023). The inaugural prototype of the multisensory theater took shape as *Sensorama*. This groundbreaking innovation amalgamated five short films to present three-dimensional videos, incorporating stereoscopic color displays, stereo sounds, aromas, gusts of wind, and vibrations. *Sensorama* was conceived with the objective of expanding training and educational opportunities for civilian, military, and industrial personnel while mitigating associated risks. Convincing investors to support the AR technology took time due to its high cost. (Vertucci et al., 2023)

In 1968, the inaugural head-mounted display system, known as The Ultimate Display, was developed by American researcher Sutherland (Haugstvedt & Krogstie, 2011). A significant milestone in the advancement of AR technology occurred in 1975 with Krueger's Videoplace project, which introduced a projection system coupled with video cameras to generate shadows on the screen. During the 1980s, Steve Mann, known for wearable computing, created the EyeTap prototype similar to Google Glass, a wearable, voice- and motion-controlled Android device that resembles a pair of eyeglasses and displays information directly in the user's field of vision developed a few decades later. (Vertucci et al., 2023)

The term "Augmented Reality" was initially documented in the 1990s by Boeing engineers and researchers Thomas P. Caudell and David W. Mizell. They explored an AR system designed to reduce errors in aircraft and aerospace industry systems (Haugstvedt & Krogstie, 2011). Boeing emerged as one of the early adopters of AR technology in its strategic initiatives. In 1992, Louis Rosenberg pioneered the first immersive AR system, known as virtual fixtures, providing the military with virtual control capabilities. In 1993, the Knowledge-based Augmented Reality for Maintenance Assistance (KARMA) project, spearheaded by Steven Feiner, Blair MacIntyre, and Doree Seligmann, produced the inaugural prototype of an AR system designed to facilitate maintenance activities (Carmigniani & Furht, 2011). Ultrasound tracking was employed in the system to display maintenance instructions. In 1994, Paul Milgram and Fumio Kishino introduced the concept of the "virtual continuum" (Figure 1), aiming to seamlessly blend the real world with the virtual realm by integrating both AR and augmented virtuality (AV). This gives a visual representation of the spectrum from reality to virtuality and where the Mixed Realities fall within the continuum.

Figure 1
Migram and Kishino's Virtual Continuum (1994). (adapted from Milgram et al., 1994)



In 1994, AR made its debut not only in theaters but also in the medical field (Carmigniani & Furht, 2011). The first theatrical production featuring AR was *Dancing in Cyberspace*, a stage performance that featured dancers and acrobats engaging with virtual objects of human size. Simultaneously, the University of North Carolina implemented an AR application within the medical domain, enabling pregnant patients to visualize the fetus through a see-through head-mounted display system. (Vertucci et al., 2023)

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Following continued years of AR research, Sony Computer Science Laboratories introduced the first AR system utilizing two-dimensional (2D) markers, named CyberCode, in 1996. In 1997, Ronald Azuma established the most widely accepted definition of AR, stating that AR is a field that involves the integration of three-dimensional (3D) virtual objects into a real-time 3D environment (Vertucci et al., 2023). To meet the criteria for being classified as AR, Azuma explains an experience must embody three key characteristics to be classified as AR: (a) combines real and virtual, allowing real and virtual objects to coexist in the same environment; (b) interactive in real-time, in order to eliminate from this classification animated films in which computer-generated animations are superimposed on real scenes; and (c) registered in 3D, requiring that the augmented contents must interact contextually with the scene. (Vertucci et al., 2023).

In 1998, AR was integrated into the National Football League (NFL) to display a yellow first-down line on the field for viewers. However, this application of AR deviates from Azuma's AR definition, as it lacks interactivity in real-time. In 1999, Hirokazu Kato created ARToolKit, the pioneering open-source software library that continues to be widely utilized across various operating systems, desktops, and mobile devices today (Yaoyuneyong & Johnson, 2011). Then, in 2001, Gerhard Reitmayr and Dieter Schmalstieg developed a collaborative mobile AR system catering to multiple users. This system integrated 3D graphics and a pen-and-pad interface, enabling direct interaction with virtual objects. In 2002, Bruce H. Thomas introduced ARQuake, marking the inception of the first outdoor AR game system. ARQuake utilized a global positioning system (GPS), a digital compass, and vision-based monitoring. Interestingly, the Pokémon GO system later adopted a similar setup to ARQuake (Vertucci et al., 2023).

In 2003, Daniel Wagner and Dieter Schmalstieg developed the initial handheld AR system on a Personal Digital Assistant (PDA) equipped with a commercial camera. This laid the foundation for the integration of AR into smart devices, facilitated by the system's architecture built on wireless networking. Subsequently, in 2004, Mathias Möhring introduced the first 3D marker tracking system for mobile devices (Arth, et al., 2015). In 2005, Andres Henrysson transitioned ARToolKit to the Symbian operating system, expanding the potential for additional AR applications to be developed for mobile phones. In 2006, Nokia introduced MARA (Mobile Augmented Reality Application), a multi-sensory AR system for mobile phones. MARA enabled users to identify and save information about objects, and when the mobile device was equipped with a global positioning system (GPS) and suitable software, users could also locate friends using the system. In 2008, coinciding with the introduction of the first Android device, Mobilizy debuted the Wikitude World Browser with AR. This innovative AR browser integrated GPS and Wikipedia data, providing a real-time camera view for Android smart devices and earning the distinction of being the first AR browser. In 2009, SPRXmobile introduced Layar, an additional AR browser. Layar utilized GPS, a camera, and a compass to recognize the environment, seamlessly integrating real-time information onto the screen (Arth, et al., 2015).

There was a rapid integration of AR devices across various industries. In 2013, Google introduced Google Glasses, leveraging AR content through Bluetooth connectivity (Arth, et al., 2015). Microsoft followed suit in 2016 with the release of HoloLens, their version of smart glasses. HoloLens featured a combination of AR and mixed reality (MR), rendering them more advanced and correspondingly more expensive than Google Glasses. In 2017, Apple unveiled the ARKit software development kit (SDK), while Google introduced *ARCore*. These AR systems significantly boosted the number of active users, leading to substantial enhancements in SDKs throughout 2018 and 2019. The upward trajectory of user numbers persists, driven by the expanding possibilities for AR experiences on smart devices. By 2020, the Reality-Virtuality Continuum (Figure 2) expanded to define mixed reality and further refine and contextualize extended reality.

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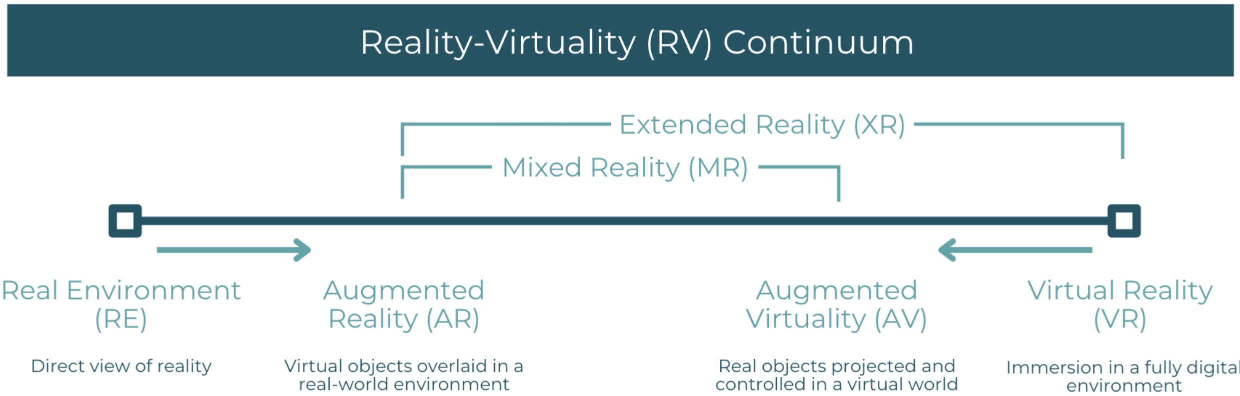
Figure 2
Updated Reality-Virtuality (RV) Continuum: Representation of Extended Reality Technologies on the Reality to Virtuality spectrum, adapted from IxDF, 2022 (https://www.interaction-design.org/literature/topics/virtuality-continuum)

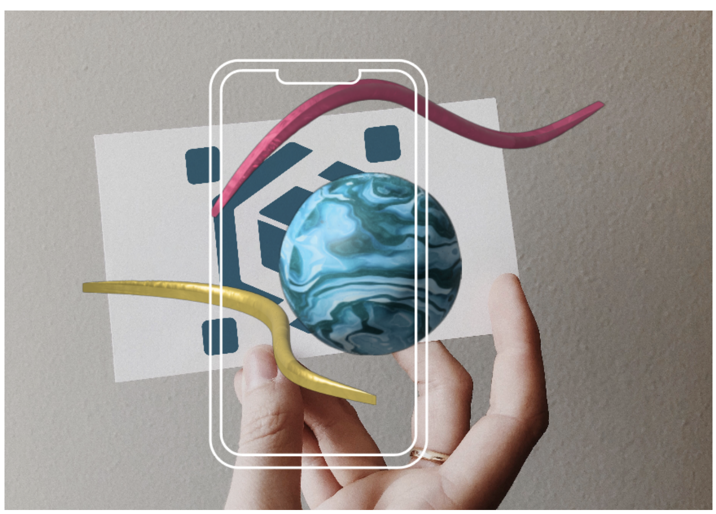


AR Technology Components

Based on the history and application of AR, for users to view or engage with the virtual objects in augmented reality experiences, there needs to be a viewing screen and a key, or trigger, as a marker. In the context of augmented reality education presented in this paper, we introduce three fundamental ways to view virtual objects, also referred to as holograms, displayed on product applications: marker-based AR, markerless-based AR, and location-based AR.

Marker-based AR, also known as image recognition AR, involves using a physical object or marker to display virtual objects in the real world, using real-world triggers to activate the experience (Figure 3). The most common example is scanning a QR code that reveals additional information when viewed through a mobile app. This type of AR relies on predefined markers and can be limited in terms of its capabilities.

Figure 3
Marker-based AR. Illustration by Félicia Barrett



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Markerless-based AR, also known as surface tracking AR, uses computer vision and depth-sensing technology to detect and track physical surfaces in the real world without the need for predefined markers (Figure 4). This allows the use of any and all parts of the physical environment and a more natural and seamless integration of virtual objects into the real-world environment.

Figure 4
Markerless-based AR.Illustration by Félicia Barrett

Location-based AR, also known as geolocation AR, uses GPS or other location data to place virtual objects in specific locations in the real world (Figure 5). This ties augmented reality content to a specific location. This type of AR is commonly used in navigation apps to provide directions and information about nearby points of interest.

Figure 5
Location-based AR. Illustration by Félicia Barrett

Real-World Augmented Reality Applications
Beyond just viewing virtual objects, users can also interact with them through gestures, voice commands, or touchscreens. These interactions can vary based on the specific AR application and its intended use. For example, a furniture shopping app may allow users to place furniture virtually in their home and adjust its size and placement through touch gestures, while a museum AR tour may allow users to learn more about an exhibit by speaking a voice command.

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In addition to these traditional forms of interaction, advances in technology have also allowed for more immersive AR experiences. This includes the use of haptic feedback, which provides physical sensations through vibrations or movements within a device, as well as the integration of AR with other technologies such as virtual reality and artificial intelligence. The following are some examples of real uses of AR on the market today.

Snapchat

Snapchat serves as a notable illustration of AR interactivity that enhances experiences primarily for entertainment purposes. Through its World Lenses, in-app addition, AR tools facilitate the integration of personalized Bitmoji animated characters into the user's surroundings with a simple snap (Figure 6). Users have the flexibility to customize their Bitmoji characters and choose various actions, allowing them to shape their AR Bitmoji experience according to their preferences.

Figure 6

Snapchat World Lenses, 2017 (source from Etherington, 2017)

Pokémon GO

In 2016, Pokémon GO played a pivotal role in expanding the realm of gamification through AR. The game enables players to explore the real world while on a quest to collect various virtual Pokémon characters (Figure 7). As users move through physical spaces, these characters appear on their devices when in close proximity. The objective of the game is to gather a diverse collection of Pokémon characters, enhancing the interactive and immersive gaming experience.

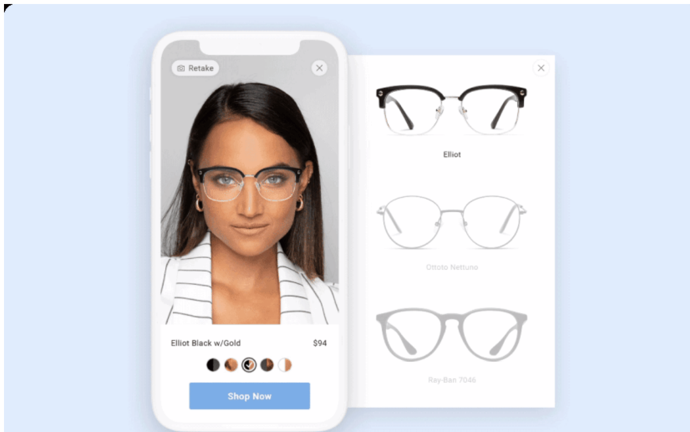
Figure 7

Niantic Pokémon GO, 2023 (source: https://pokemongolive.com)

GlassesUSA

GlassesUSA employs AR tools to augment its marketing strategy, offering users the ability to virtually try on and assess eyeglass frames via a downloadable app (Figure 8). Users can upload an image of themselves or use real-time AR on their mobile devices to visualize how different frames look on their faces. This implementation of AR enhances the customer's decision-making process, increasing the likelihood that they will be satisfied with their eyeglass selection.

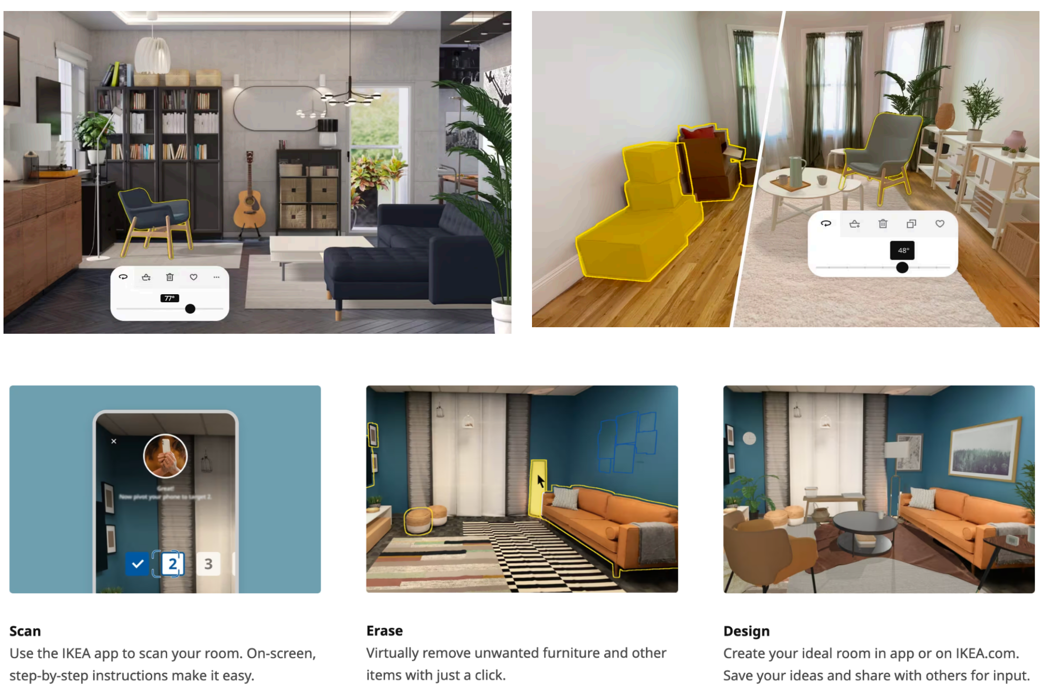
Figure 8
GlassesUSA, 2023 (source: https://apps.apple.com/us/app/glassesusa/id1618058891?mt=80)



Ikea Kreativ

The IKEA Kreativ app (Figure 9), created by Inter IKEA Systems, utilizes AR to help users style their space by considering the dimensions and scale of the products they are interested in. When using IKEA Kreativ, users can explore a variety of combinations and options for items to determine what works best for them both functionally and aesthetically. The initial step in using Kreativ involves selecting the type of space being designed, whether it is starting with an empty room or using one of IKEA's pre-designed room templates.

Figure 9
IKEA Kreativ & Inter IKEA Systems, 2017 (source: https://apps.apple.com/us/app/ikea/id1452164827)



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Augmented Reality Tools

There are several tools available for creating AR experiences. Below we introduce the ones considered for classroom integration. We have chosen Adobe Aero as a tool for design and development in the context of the teaching framework presented in this paper. Tool descriptions and an outline of the strengths of Adobe Aero and the rationale for its selection are presented below.

Artivive is a web-based augmented reality (AR) platform designed for users to craft compelling AR experiences using either 3D models or animations. Unlike Adobe Aero, Artivive exhibits certain limitations in terms of customization and the complexity of creating AR experiences. While it provides a user-friendly interface for AR content creation, it may not offer the same extensive range of features and design flexibility found in more advanced tools like Adobe Aero.

8th Wall and *Augment* are web-based AR platforms that distinguish themselves from Adobe Aero through their broader software compatibility, catering to both iOS and Android devices. They both utilize markerless tracking technology, eliminating the need for a physical anchor in the environment for AR experiences to function. This technology enhances the flexibility and spontaneity of deploying AR content, as it can seamlessly integrate into various surroundings without the reliance on specific markers.

Lightship, the AR platform renowned for developing Pokémon GO, specializes in creating location-based AR experiences. This approach opens up possibilities for interactive activities centered around specific locations, such as games or tours. Lightship incorporates AR Cloud, a digital copy of the real world, enabling the consistent deployment of AR content in predefined locations instead of starting from scratch. Lightship supports multi-user AR experiences, fostering collaborative engagement among users. A distinctive feature is the real-time modification and adjustment of AR content and updates by users, providing a dynamic and interactive element to the experiences created on the platform. The most recent development in AR platforms would be AR Makr, which is offered as an application. Within the application, users are able to sketch, scan, and transform 2D or 3D objects.

Adobe Aero is a cross-platform and multi-device application that enables creators to utilize a block-building approach for adding motion and interaction, decreasing the need for traditional coding skills. This innovative tool provides a versatile range of interactions, including buttons and behavioral triggers, offering creators diverse options for crafting engaging experiences. Notably, Adobe Aero supports various file types, from 3D models to images and animations, enhancing its flexibility. Designed with creator convenience in mind, Adobe Aero prioritizes compatibility with iOS devices, ensuring a seamless experience for Apple users. The real-time preview feature within the program allows creators to test their augmented reality files on the fly, providing valuable insights into how the AR experience will function in a given environment.
The rationale for selecting Adobe Aero is its integration with the Adobe Creative Cloud platform, which is already a major design and development tool of the visual communication design curriculum. This integration facilitates a cohesive workflow when students are simultaneously working with other Adobe software such as Photoshop or Illustrator. By being part of the Creative Cloud ecosystem, Adobe Aero streamlines the creative process, allowing for a unified and efficient approach to AR design.

Teaching Model Framework for Introducing Augmented Reality in the Classroom

This teaching model was developed in a collaborative effort out of the need to teach how to design with augmented reality in the classroom. The development of augmented reality (AR) technology opens up new opportunities for communication, interaction, and expression in various fields, including visual communication design. Nevertheless, the successful implementation of AR requires a comprehensive understanding of its key concepts, features, and potential applications. To address this need, a teaching model was developed to facilitate the acquisition of AR literacy among undergraduate students in Visual Communication Design.

Media to Application Framework

This framework offers an approach to teaching AR by guiding students through the entire process of developing an AR application from ideation to execution to testing and refinement. By breaking down the complex process of creating an AR application into more manageable stages, students can build their confidence and competence in AR development while also developing the skills they need to succeed in the field of visual communication design.

Moreover, it is important to note that AR literacy is an ever-evolving skill set that requires students to keep pace with the rapidly changing technological landscape. The media-to-application framework takes this into account by not only emphasizing the fundamentals of AR development but also encouraging students to stay abreast of emerging trends and technologies in the AR field. By helping students develop AR literacy, the media-to-application framework aims to provide them with a solid foundation for success in this constantly evolving medium.

Through this model, students gain in-depth knowledge of AR's technical and conceptual aspects and develop skills in designing, developing, and implementing AR experiences, which we labeled Augmented Reality Experience (ARX) (Figure 10). There are specific components required in order to create an ARX. First, a virtual object, which can either be 2-dimensional or 3-dimensional, and a real product application, be it an image, surface, or location for a marker-based, markerless-based, or location-based ARX, is needed. Then, the ARX must include how the audience prompts, initiates and views the virtual object and the product application through camera, proximity, tap, etc.

Figure 10

Augmented Reality Experience (ARX) Components

It is important to note that creating an ARX is not just about its technical aspects. In fact, one of the most critical components for a successful ARX is a well-defined concept or idea. This includes identifying the target audience, defining the message to convey, and understanding how users will interact with the augmented reality content.

Once there is a clear concept, it is time to start thinking about the design. In the context of an undergraduate classroom in the visual communication design major, ARX was simplified into four connecting segments to aid student AR literacy and varying approaches to design in AR.

The undergraduate course for which this teaching model was developed is a sophomore-level introductory course in design tools and software. The course deals with visual communication design using the computer as a creative medium. Students have opportunities to learn and expand technical skills and improve problem-solving abilities in visual communication design through class exercises and projects.

The media-to-application framework (Figure 11) is grounded in four fundamental concepts, namely 2-dimensional to augmented reality media conversion, augmented reality motion design, augmented reality interaction, and augmented reality communication and engagement. These concepts provide a structured framework for teaching AR and encourage students to think creatively, experiment with new techniques and technologies, and explore the possibilities of AR in enhancing communication and engagement.

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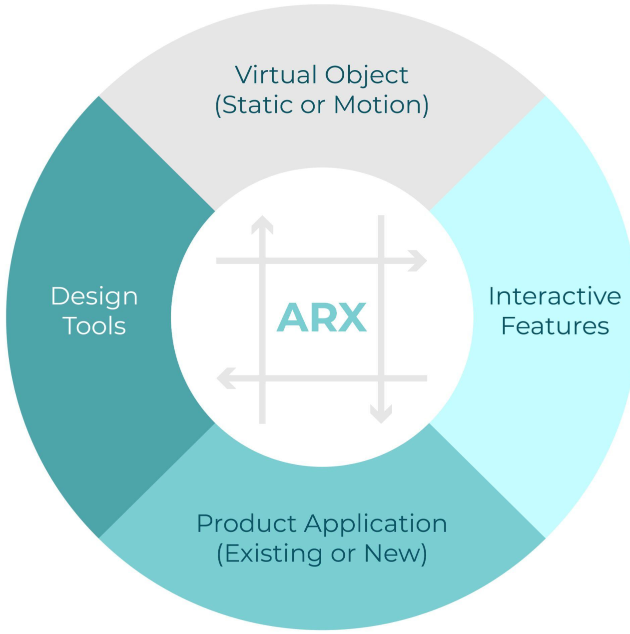
Figure 11
Media to Application Framework



The model identifies relationships between the different AR components and enables a variety of approaches for students to consider and learn from. The first relationship examined is from the approach of the virtual object, in motion or static, and the real-world product application it is related to.

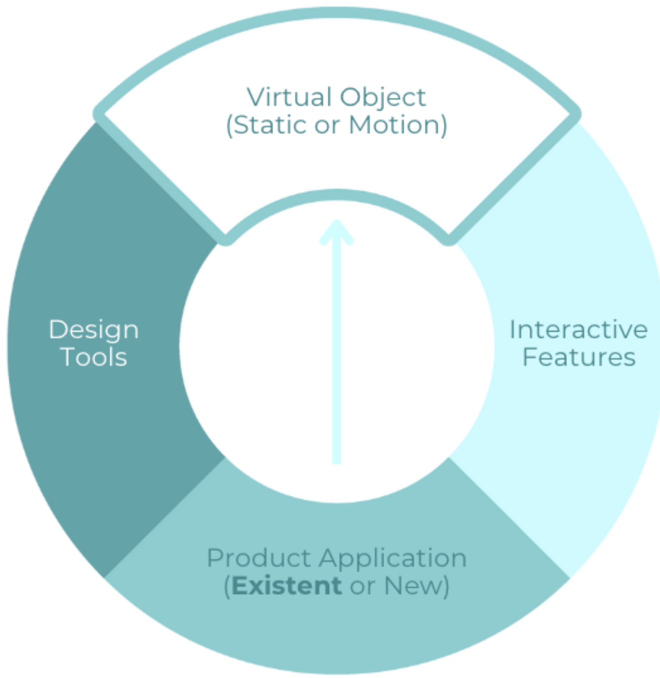
Creating an Augmented Reality Experience

When introducing AR in the classroom, there are four relationships that can occur for an AR experience: media conversion, motion design, interaction, and communication and engagement.

2-Dimensional to 3-Dimensional Media Conversion

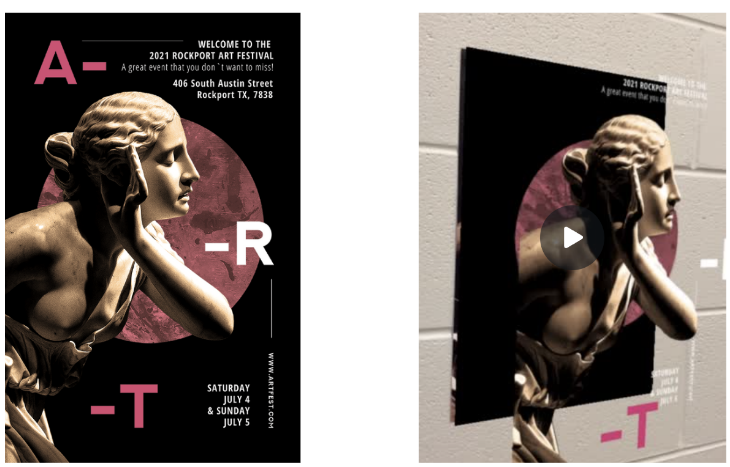
The first relationship we introduced was between a product application and the virtual object (Figure 12). To familiarize students with the concept, we started with works they were already acquainted with, such as poster design. In this context, students were introduced to an augmented reality (AR) software workspace that consisted of an existing product application and a layered poster design. The printed poster served as the foundation for creating a marker-based AR experience. By manipulating the digital assets derived from the poster, students had the opportunity to experiment with moving, rotating, and scaling assets in 3D space to serve as the foundation for the virtual object, resulting in the creation of their own AR experiences.

Figure 12
Existent 2D Product Application to 3D Virtual Object



The lesson involved using an existing product application, specifically a layered poster design. Before importing the file into Adobe Aero, students prepared it in Adobe Photoshop by checking and grouping layers. Once in Adobe Aero, students engaged in experimenting with the 3D manipulation of assets—moving, rotating, and scaling—to craft an augmented reality experience (Figure 13). This stage enabled students to understand marker-based AR by setting the poster design as an image anchor, linking the digital content with the physical print of the poster.

Figure 13
Demonstration File: 2-Dimensional to 3-Dimensional Media Conversion Assignment



AR Motion Design

Students were tasked with creating a virtual object with the intention of adding motion through animation to a new marker or markerless-based product application (Figure 14). Students experimented with the speed,

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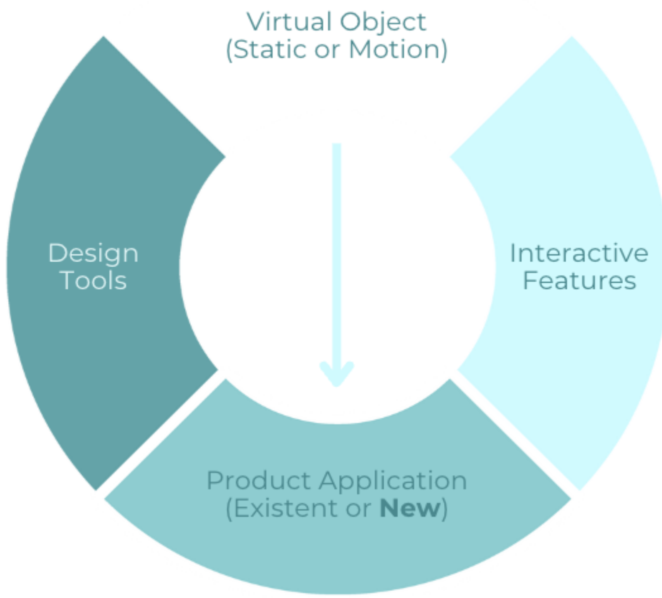
placement, scale, etc., to apply motion to an originally static virtual object. They were tasked to apply their virtual object to a new product application to enhance an intended meaning.

Figure 14
Virtual Object in Motion to New Product Application



Advancing to the next stage of the teaching model, AR motion design, students delved into the process of generating a portable network graphics (PNG) sequence using Adobe Photoshop. This step aimed to prepare files for later integration into Adobe Aero, enabling the creation of a virtual object detached from a static object (Figure 15). By introducing motion through animation, students explored new possibilities for marker or markerless-based product applications. Once imported into Adobe Aero, students engaged in experimenting with the speed, placement, and scale of the sequence to apply dynamic motion to the initially static virtual object.

Figure 15
Demonstration File: AR Motion Design Assignment

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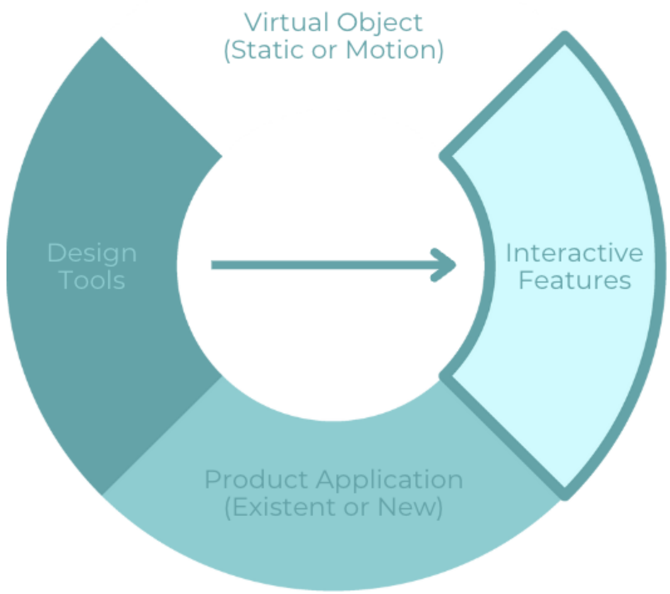
AR Interaction

Students were exposed to a range of design tools, which showcased the various possibilities they have when it comes to creating virtual objects and product applications. Through the utilization of these design tools, they successfully generated a static virtual object that could be incorporated into a markerless product application. The extent of the interactive features that students were able to develop aligned with the specific types of design tools they employed (Figure 16). Their objective was to enhance the resultant augmented reality (AR) experience by appending interactive features to their virtual objects.

Figure 16

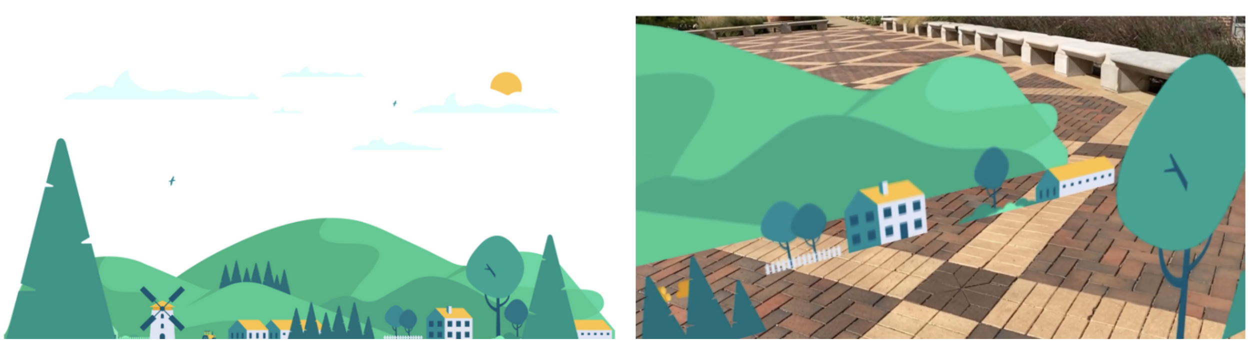
Design Tools to Determine Interactive Features Available



In the interaction stage, students were acquainted with a range of design tools that offer diverse options based on whether they are crafting virtual objects or product applications. The students utilized these tools to craft a static virtual object for integration into a markerless product application (Figure 17). They discovered that the interactive features at their disposal were contingent upon the specific design tools employed. After designing their virtual object, students were challenged to incorporate interactive features, elevating the overall AR experience.

Figure 17

Demonstration File: AR Interaction Assignment



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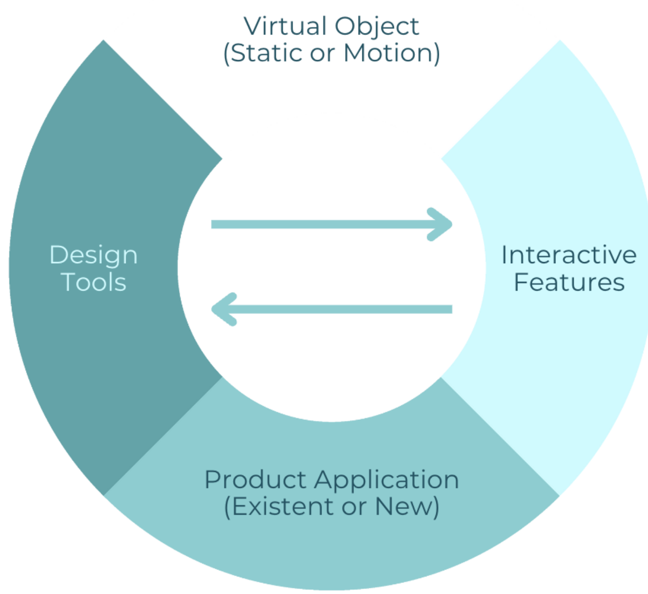
AR Communication and Engagement
The students were assigned two projects aimed at enhancing their concept-building skills. These projects involved utilizing an existing virtual object and product application that were introduced to them during the course, specifically in relation to the design tools used. The first project focused on creating a 2D surreal poster design product application, while the second project involved developing a 3D product look using a virtual object. In order to achieve their final designs, the students were required to problem-solve and incorporate appropriate design tools and interactive features, starting from both a product application and a virtual object as the main deliverable (Figure 18).

Figure 18
Design Problem-Solving Project between Design Tools and Interactive Feature Relationships



The objective of these projects was to encourage the creation of an AR experience that not only showcased the practical application of their designs but also effectively communicated their design concepts.

Case Studies

The following are samples of student work that came after the series of assignments using the media-to-application framework.

Surreal Movie Poster: AR Communication and Engagement
Students learned Adobe Photoshop at the beginning of the semester. After completing the course software learning objectives, students were assigned a project to challenge their conceptual and technical skills. This project was in the form of a surreal movie poster design.

Students were tasked to create a surreal or impossible scene in the real world with multiple composited images to be featured on a poster for an upcoming fictitious movie. The genre and title were open, but their designs and concepts were to reflect them.

The introduction of the augmented reality experience component aimed to foster problem-solving skills among students, enabling them to enhance the communication and engagement of their surreal movie poster concepts. Within this context, students were encouraged to explore diverse possibilities offered by Aero, thus granting them the flexibility to consider different approaches for leveraging specific features. For

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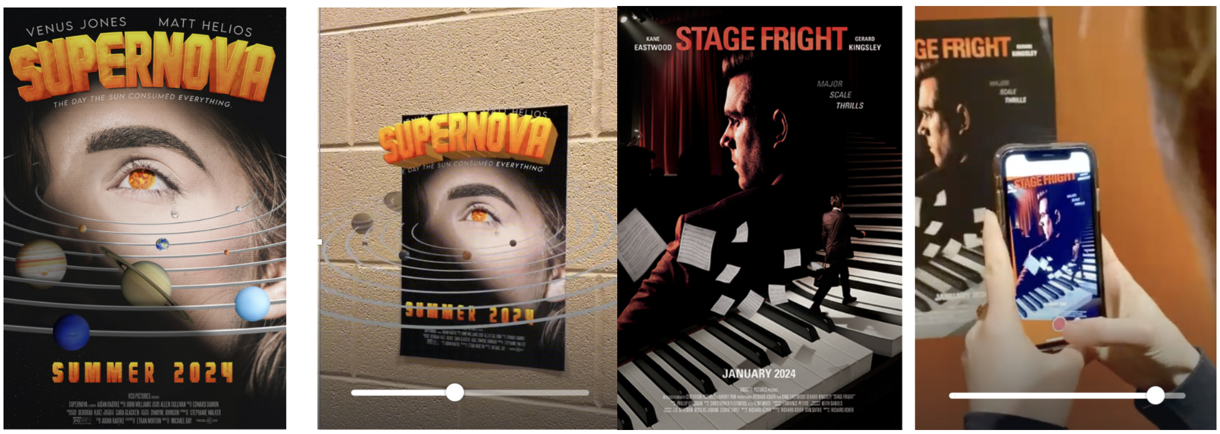
instance, they had the option to extend their design by bringing Adobe Photoshop layers or elements into the three-dimensional realm. Moreover, they could incorporate animations using PNG sequences or .gif animations derived from the layers of their poster's PSD file. Furthermore, students were empowered to incorporate additional assets of their own choosing, thus affording them the opportunity to augment their posters with personalized elements. Sound and audio also played a vital role, serving as supplementary enhancements. The project’s open-ended nature prompted students to ideate, encouraging them to explore and determine the most valuable elements to incorporate into their concepts. Ultimately, this approach enhanced the audience's overall experience when viewing the posters, solidifying the value and impact of their creations (Figure 19).

Figure 19
Student Work: Existent 2D Product Application to 3D Virtual Object



In the examples above, the students were able to incorporate various design tools and interactive features to create an engaging AR experience through 3D and motion design approaches. The students started with the existing product application. Then, the creation and implementation of the virtual object could be done from their Adobe Photoshop files or through other means and design tools. The combination of 3D models, animations, and sound elements resulted in engaging and visually striking concepts that effectively conveyed the surrealism of their movie posters. This exercise provided students with practical skills in utilizing design tools, interactive features, and the relationship between them to enhance their creative projects.

Product Look: AR Communication & Engagement

The second component of the AR communication and engagement stage involved the design tools and interactive features focused on starting from the creation of the virtual object as the final deliverable. The purpose of this project was to encourage students to think about augmented reality in the context of the professional world and its role in client relationships and sustainability. One of the key benefits of AR is its ability to enhance communication and collaboration between clients and designers. By using AR technology, businesses can showcase their products or services more engaging and interactively, allowing clients to understand better and visualize the result. This not only improves client satisfaction but also helps designers to stand out in a competitive market.

Consumers are more likely to buy a product if their first impression of the packaging is positive. Students were tasked to choose a company they would like to create packaging and set up a product look. The goal here was to engage students in taking client work and presentation into consideration. They needed to determine potential materials and/or colors supporting the brand/product identity and fully render high-quality virtual objects (Figure 20). Moreover, AR has the potential to contribute to sustainable practices in various industries. For example, in architecture and construction, AR can be used for virtual building walkthroughs, reducing the need for physical prototypes and minimizing waste in the construction process.

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Figure 20
Student Work: Existent 2D Product Application to 3D Virtual Object

The student examples above showcase the virtual objects created as the main component of the augmented reality experience. These particular projects were chosen for the successful implementation of AR in a professional presentation setting as if they were presenting to clients. In terms of product visualization and marketing, AR has the potential to be a valuable tool and sustainable tool for businesses.

Conclusion

This framework for teaching augmented reality (AR) to enhance visual communication and create engaging experiences allowed students to tap into the resources available in the classroom, such as Adobe Creative Cloud, to expand their understanding of augmented reality and its many applications, including critical thinking about sustainability in design development. The framework allowed students to explore AR methods of communication and design through hands-on activities. Students build upon previous design work to create AR experiences, enhancing their understanding of visual communication design applications. Developing augmented reality literacy enables students to evolve marketing strategies for design communication applications. Integrating AR into a visual communication course can expand on the use of design elements, considering aspects such as user interaction and engagement. This exercise allowed students to develop their visual communication skills, broadening their experience from 2D to 3D concept development and further understanding its potential for enhancing client satisfaction and sustainability in design practices. In the future, we want to broaden the scope of the current framework on more complex AR development applications, including creating AR experiences for teaching and learning. Exploring opportunities for student collaboration with local businesses to implement practical AR applications is also an important aspect of design education and a way to promote service learning. By providing students with the tools and skills to communicate effectively through augmented reality, we prepare them for a future where AR is becoming an increasingly important aspect of design practices across various industries. Ultimately, incorporating AR into visual communication education enhances student learning and prepares them to succeed in the ever-evolving design world.

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