IDSA

INTEGRATING TECHNOLOGY TO DESIGN SKETCH

A USER EXPERIENCE RESEARCH AND PRODUCT SKETCH PRACTICE IN INDUSTRIAL DESIGN EDUCATION WITH AUGMENTED REALITY (AR) TECHNOLOGY

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PAPER ABSTRACT: Understanding users and analyzing their needs is a commonly required skill during the research phase of the design process and designing a product. However, researching real users can be challenging for students in the early stages of the industrial design curriculum due to their limited experience and training. This case study aims to help students become familiar with user research by analyzing simple and well-known fairy tale stories, defining the characters' needs, and designing products to solve problems based on their research. The goal is for students to recreate the original stories using out-of-the-box thinking, design products for the main characters, and enhance their creativity and storytelling skills using Augmented Reality (AR) tools. This paper compiles data on the project results, processes, and student feedback collected from an industrial design drawing course involving 1st-year industrial design students.

Keywords: Storytelling, Creativity, User Research, Fairy Tales, Industrial Design Sketch, Augmented Reality (AR) Technology

1. INTRODUCTION

Industrial Design (ID) is the professional practice of designing products, devices, objects, and services used by millions of people around the world every day (IDSA, 2023). The fundamental design drawing is one of the essential courses in the industrial design program. This course teaches freshmen students fundamental sketching skills with the purpose of visually presenting students' ideas through the use of practical exercises and various hands-on activities to develop proficiency in sketching (Tovey, 1989). This study suggests the proposal of a new curriculum by incorporating basic industrial design knowledge, user research, and skill sets for freshmen students. To achieve this, fictional users from fairy tales are used to promote students to analyze user needs and apply critical thinking to design products that solve their problems. Moreover, implementing new cutting-edge technologies such as AR in design curriculums can cultivate a new generation of tech-savvy designers that can revolutionize the world of industrial design.

2. OBJECTIVE

The main objective of this study is to introduce user research and design process to freshmen ID students. The ID process can be better illustrated by the double-diamond design process, a framework used in design thinking that consists of four stages: discover, define, develop, and deliver (Figure 1). It

emphasizes divergent and convergent thinking to explore and define the problem space, generate multiple solutions, refine the chosen solution, and deliver a well-executed design solution (Bardaro, 2021). The double diamond design process serves as a key influence in the development of our newly redesigned curriculum, encompassing the four distinct stages. However, we have tailored the objectives to align with our specific goals, focusing on motivation, creativity, user research, functionality, and technology. To effectively meet these objectives, we leverage the use of fairytales and augmented reality (AR) technology. (Figure 2).

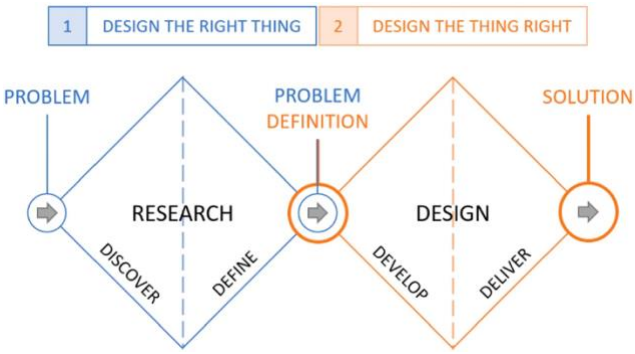

Figure 1. Double Diamond Designing Process

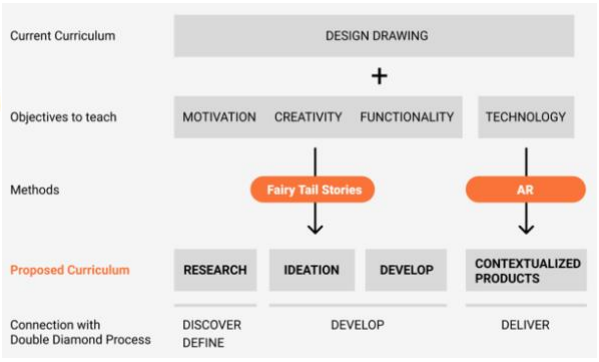

Figure 2. Proposed Design Drawing Curriculum Outline

2.1 MOTIVATION AND CREATIVITY

Generally, foundational design drawing courses emphasize the development of muscle memory through a monotonous process of repeatedly drawing and sketching. These include learning line drawing, geometric objects, texture, perspective, storytelling, context background, and physical human factors (Aldoy, 2011).

Although it is essential to develop drawing skills through repetition, students might feel unmotivated to develop only basic skills if they don't see the relevance of these skills to industrial design. Without a clear understanding of how these techniques are used in the field, they may feel like they are just going through the motions without a sense of purpose or direction. Introducing basic industry-level skills can encourage innovative thinking and creativity that sparks students' ingenuity by giving students a concrete goal to work towards. Successful design problem-solving requires not only developed skills, but also a high level of creativity (Casakin, 2005). Industrial design students should think creatively to come up with new ideas and approaches to design challenges. They need to be able to imagine new products, visualize how they might be used, and anticipate how they might be manufactured and marketed. Without creativity, it is difficult to come up with ideas that are truly original and useful.

2.2 FUNCTIONALITY

Taking into consideration the function of a product is critical during the industrial design process as the primary goal of industrial design is to create products that are both visually appealing and functional. Louis Sullivan's famous axiom "Form follows function" best illustrates the importance of balancing between a product's form factor and function. After understanding the user after conducting user research, designers consider different types of functions and features that will resolve the user's problems. Industrial designers take into account factors such as ergonomics, usability, and safety when designing a product. By considering the function of a product throughout the design process, industrial

designers can create products that are not only visually appealing but also meet the needs of their intended users. This can lead to increased user satisfaction, loyalty, and commercial success.

2.3 INTEGRATION OF TECHNOLOGY

In our exponentially advancing world of technology, the implementation of cutting-edge technological resources such as Augmented Reality (AR) can significantly enhance industrial design students' learning experience. The combination of modern-day technology and traditional sketches can result in countless possibilities for application to industrial design students (Schneider, 2021). AR can provide a more immersive and interactive learning experience that allows students to visualize their designs in three dimensions, making it easier for them to understand the relationship between form, function, and context. Through the integration of these cutting-edge technologies, students can better visualize their products in real-life environments, enhancing their understanding of how their products interact with the surrounding environment.

3. METHODS

The proposed design drawing course is structured around creating two storyboards with fairy tales (AS-IS and TO-BE), user personas, hypothesized products, and visualizing the context with AR (Figure 3).

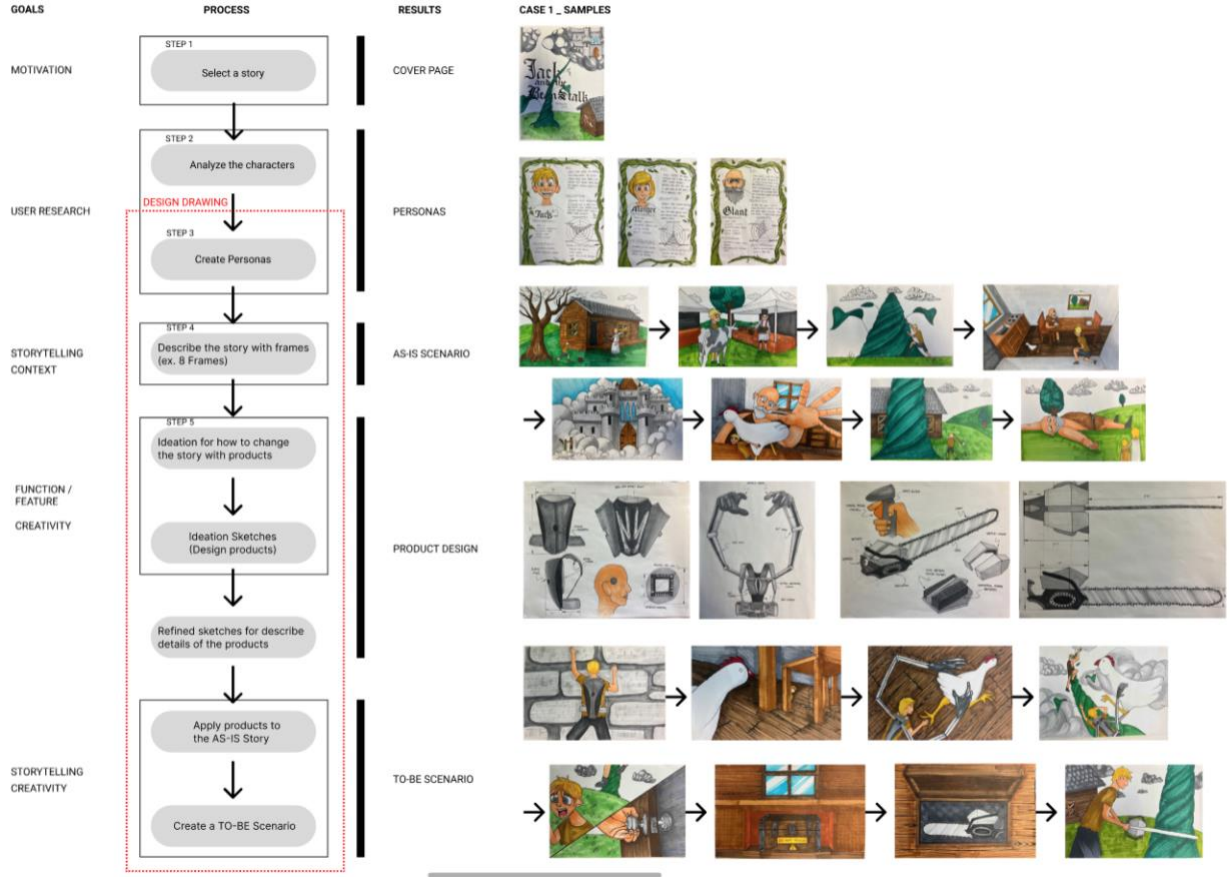

Figure 3. Structure of Proposed Course Flow

3.1 FAIRY TALE

As an educational curriculum, instructing freshman industrial students on the essential skills to perform user research on real-life users is a difficult task, as students lack the necessary fundamental knowledge and experience. Using simple fairy tales with a clear plot line can be a better choice as it provides a more accessible and engaging way to introduce the concepts of user research. Since most fairy tales have simple storylines with an apparent conflict, rising action, climax, and resolution, students are able to create character personas by identifying the user's demographics, pain points, goals, and motivation (Joosen, 2011).

Using fairy tales can help students grasp the fundamental concepts of user research before moving on to more complex and nuanced real-world scenarios. It can help them develop a solid foundation in the principles of user-centered design, which they can then build upon as they progress through their studies. It is important to acknowledge that using fairytales has its limitations, such as how they can be time/context/culture specifc, and promotes stereotypical human characteristics. However, fairytales provide an easy entryway for beginner ID students to begin grasping concepts and introducing fundamental processes of designing products. It should be clarified that fairy tales should not be the sole basis for real-world design, but rather serve as an educational stepping stone. As students progress, they will encounter more diverse and complex user research scenarios that align with professional practices.

3.2 USER RESEARCH

User research is critical for industrial design because it helps designers understand the needs and preferences of the consumers who will use the products they are designing (Baxter, 2015). By conducting user research, designers can gain valuable insights into how users interact with products, what features they find most useful, and what pain points they experience. However, introducing user research to freshmen is a difficult task, as students lack the necessary fundamental knowledge and experience. Additionally, real users possess complex characteristics that requires extensive research and understanding that can prove to be difficult for students to achieve. This study uses characters from well-known fairy tales and folklore to simulate real-life users and simplify the complex variables in real life. This also encourages students to think out of the box, using their creativity to hypothesize fictional characters' behaviors needs, motivations, and pain points.

3.3 AUGMENTED REALITY TECHNOLOGY

Augmented Reality (AR) is a technology that overlays digital information, objects, or images onto real-world environments. This is typically achieved through a mobile device equipped with an AR-enabled camera and software. This means that AR technology is relatively more accessible to students as most people with mobile devices utilize AR technology (Shen, 2010). AR also enables designers to visualize and interact with their designs in real-world contexts. By superimposing digital models onto physical spaces, designers can explore the ways in which their designs will interact with and impact the surrounding environment. AR can be used to create interactive product demonstrations, allowing designers to explore and interact with products and help them identify areas for improvement and refinement.

This study was restricted to the use of only mobile AR applications due to their affordability and accessibility. Most mobile apps on the market are free to use and does not require additional hardware

other than a mobile phone. This is ideal to reaching a larger student population with diverse financial backgrounds as the vast majority already have a smartphone. Therefore, three different AR mobile apps were used to conduct research and testing, namely: Reality Composer, uMake, and Adobe Aero. The three apps were selected based on their user rating, award recognition, and credibility from well-known developers. Figure 4 illustrates an in-depth comparison chart between cross-platform compatibility, availability of file types when importing and exporting, as well as a list of essential features. Overall, uMake has the most features (animation, rendering, textures, materials, ect.) and potential to create sophisticated and elaborate projects. However, when comparing the AR view of each software, uMake has a relatively laggy and choppy viewport while Reality Composer and Adobe Aero have very smooth viewports in integrating digital files with real-life environments. Additionally, it is noteworthy to mention that Adobe Aero's is the only application that is compatible with iOS, Android, and Windows devices. It is crucial to take into account that not all students use Apple devices.

Basic Information + Features (AR)					
	Reality Composer	uMake			Aero
		Free	uMake	Umake+	
Seller / Developer	Apple	uMake Inc.			Adobe Inc.
Compatibility	iPhone, iPad, Macbook	iPhone, iPad, Macbook			Android, iPhone, iPad, Windows, Macbook
Price	Free	Free	$7.99/month	$11.66/month	Free
Import	USDz	SVG, SKP, OBJ, STL, IGES, STEP	JPG, PNG, SVG, SKP, OBJ, STL, IGES, STEP	JPG, PNG, SVG, SKP, OBJ, STL, IGES, STEP	PSD, JPEG, OBJ, GLB, FBX
Export	Reality File		PNG, OBJ, STL, IGES, STEP, USDz	PNG, OBJ, STL, IGES, STEP, USDz	REAL File Behance
Physics	✓				
Animation	✓		✓	✓	✓
Rendering		watermarked	✓	✓	
Templates			✓	✓	
Environment			✓	✓	
Textures			✓	✓	
Materials			✓	✓	
AR Rating	Excellent (smooth flow and quick responses)	Framerates are very slow and do not show 3D objects well in AR view			Excellent (smooth flow and quick responses)

Figure 4. Comparison Char of AR Software

4. CASE STUDY

To implement these technologies into the course curriculum, data was collected on the effectiveness of different combinations of AR in different scenarios. Namely, the advantages and disadvantages of the following combinations were observed: physical sketch, physical sketch + AR, and 3D CAD + AR.

CASE 1: PHYSICAL SKETCH

Using physical sketches is the most accessible and reliable option for design drawing courses because most students have prior experience using pen and paper. Regardless of each individual student's level of sketching, having a familiar medium as a solid foundation is essential for building advanced sketching skills. However, the design process of physical sketches is time-intensive and doesn't perfectly align with testing in various environments or contextual backgrounds. As shown in Figure 5, students' time and effort are often divided to create elaborate products and environments. Although industrial design students should consider the context of their product and its integration into the surrounding environment, their primary focus should be on conveying creativity and ideas into products. Spending excessive time designing the environment detracts from students' ability to create different iterations, incorporate more functions, and add more features. Additionally, it is challenging to fully visualize how two-dimensional product sketches interact with the real world. Designers often encounter obstacles when transferring ideas from 2D to 3D objects, where the size and form factor of the product were not fully considered during the design phase.

Figure 5. Physical sketches of user persona, storyboard, and products

CASE 2: PHYSICAL SKETCH + AR

With the combination of physical sketches and AR, students can easily bring their selected products into the real world, giving them a better understanding of context, size, and how their product will interact with its surrounding space. This significantly improves time efficiency to ideate and create product sketches. Students can test their ideated products in numerous different environments by importing a scanned image of their drawing, then using an AR view to view how their product interacts with the real world. After our extensive research, we found that Reality Composer is not suitable for importing 2D images as it only supports USDz files. On the other hand, uMake and Adobe Aero do a good job of displaying physical sketches in AR scenes. We found that Adobe Aero has more advanced AR technology compared to uMake, as its AR viewer is very smooth and objects fit seamlessly into the world. However, Adobe Aero is difficult to manipulate 3D objects as it works directly in the AR viewer (Figure 6). Overall, importing 2D images into AR is a quick and fast way for students to gain a better understanding of their product's size and context without the need to draw the environment, but this creates awkward perspectives as the 2D image will become flat when walking around to the side (Figure 7).

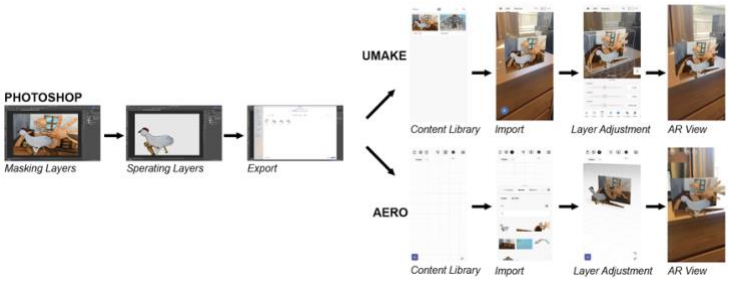

Figure 6. Flow chart from physical sketch to AR

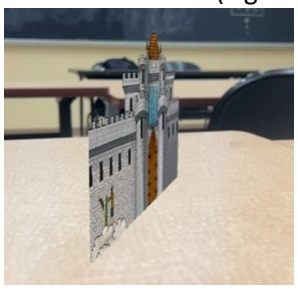

Figure 7. Problems with AR

CASE 3: 3D MODELING + AR

One possible solution that fixes the problem of awkward perspectives is using 3D CAD models instead of 2D images. Figure 8 demonstrates how the 3D modeled chainsaw better fits into the AR environment. With 3D models, the scene feels more complete, and students can have a better understanding of how their product interacts with the environment from all angles. Although 3D CAD has a higher difficulty as not all students are familiar with designing products within a 3D space, Shapr3D is very intuitive and the best entry-level 3D CAD software for students to beginning to start learning about 3D modeling. It is a powerful tool that mostly involves simple motions like dragging and pulling to extrude faces, filet edges, and numerous other functions. Compared to previous proposed cases, CASE 3 will take more time to complete, but will yield better results.

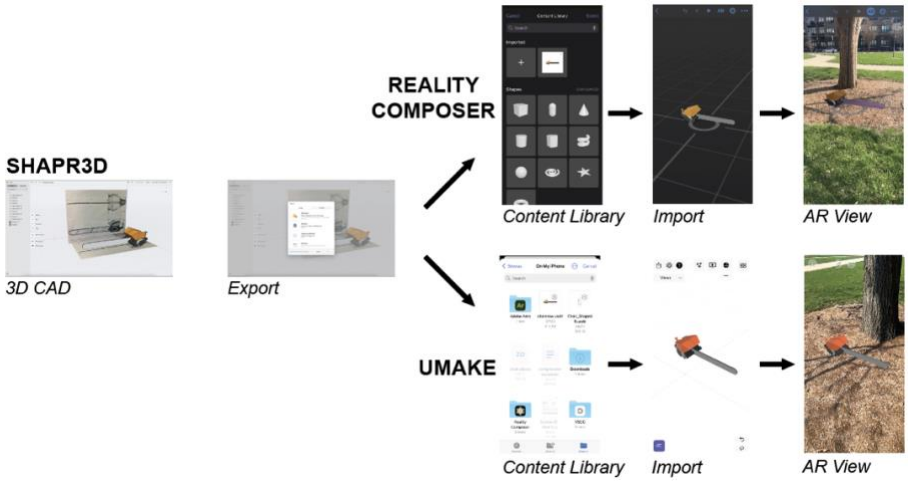

Figure 8. Flow chart from 3D CAD to AR

5. RESULTS

A class survey was distributed to 11 freshmen students at the conclusion of the semester to gather their feedback on the newly designed curriculum. The survey results revealed that the majority of the class expressed support for the integration of AR technology and the utilization of fairytales to simulate real users (Figure 9). To illustrate the contrast between traditional design drawing curricula and the newly proposed curriculum, examples of student works from previous years were provided. The students' responses indicated that the new curriculum had a significant positive impact on their learning experience. They appreciated the increased creative freedom, enhanced critical thinking, and clearer understanding of the purpose and application of design drawing. All in all, the results of this study show promising potential to enhance industrial design curriculums.

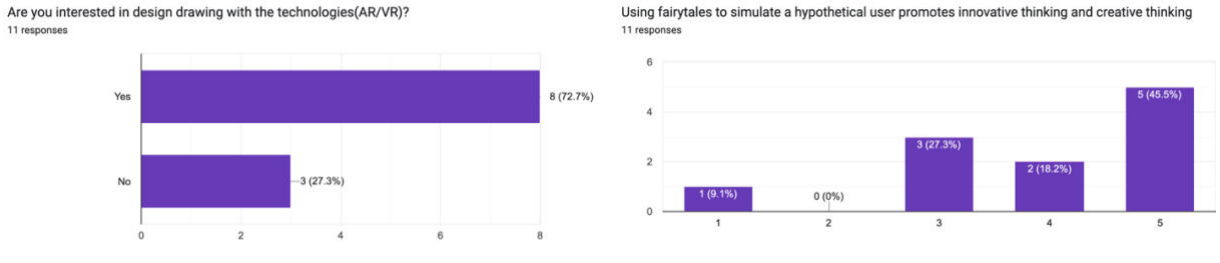

Figure 9. Class Survey Results

6. CONCLUSION

The purpose of this study is to investigate how current traditional design drawing courses can be improved with the addition of technology, rather than aiming to replace existing methods. By incorporating AR technology into traditional design drawing curricula, students' efficiency in creating higher-quality products within shorter time frames can be enhanced. Furthermore, it enables students to test and interact with various environments, facilitating better visualization and understanding of how their ideas will appear and function in the real world. Educators should utilize different cases based on varying objectives and purposes. In CASE 1, fundamental sketching skills should be introduced at the beginning of the freshman course, allowing students to familiarize themselves with physical sketching before transitioning into the digital world. Building upon CASE 1, CASE 2 can involve the utilization of AR to visualize students' sketches. CASE 3, on the other hand, should be reserved for sophomores who possess more experience and familiarity with designing in 3D spaces. It is important to note that this step should be considered after designing the product through sketching.

While AR proves to be powerful in creating 3D objects, existing software on the market is not specifically designed for the purpose of 2D sketching and storytelling. Therefore, the team's next mission will involve the development of suitable AR software and functions for industrial design sketching courses. Such software holds immense potential to enhance students' sketching experience, aligning with the intended focus of the study.

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