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DESIGNING WITH VIRTUAL ENVIRONMENTS: EXPLORING OBJECT ATTACHMENT THROUGH DIGITAL INTERACTION

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ABSTRACT
The purpose of this master's study pilot research project is to develop a framework for evaluating object attachment in a digital space. The article examines product design development through a game studies lens, making use of cross-disciplinary references. It seeks to fill a research gap by investigating the effectiveness of digital user engagement with object attachment via the research question, 'How can digital interaction be utilized to evaluate object attachment?' The study investigates the usefulness of a virtual environment in assessing user attachment to objects in a digital space, through a prototype experience and personalized interviews. Notes and data from the play experience were triangulated with qualitative data from interviews, to provide an analysis of opinions on object attachment inside the designated virtual environment. The aim of this pilot research project is to prepare for further studies of novel, inventive, and alternative methodologies for investigating user opinions of designers' and engineers' works. The discussion elaborates on the flexibility for educators to apply other design theories to such a framework. Finally, the study will examine the benefits and applications of this preliminary framework for students and educators of product design in a sustainable and collaborative context.

Keywords: Prototype, framework, attachment, user interaction, virtual, sustainability, education

1 INTRODUCTION: DIGITAL INTERACTION AND OBJECT ATTACHMENT
Attachment is pivotal to product designers, as understanding how users become attached to a product will help designers develop emotional experiences with the product [1]. Designers have been utilising and experimenting with VR, games, and real-time experiences as the technology behind them have grown over time. User-object attachment has been a constant subject of multidisciplinary discourse, from psychologists to consumer researchers. The research question was inspired by recent studies on digital object attachment [2], emotional attachment to characters in games [3], and attachment to virtual possessions in games [4]. There has been little research on exploring the effectiveness of digital user interaction with object attachment. This study aims to investigate this missing link through the research question, '*How can digital interaction be used to evaluate object attachment?'* Exploring this framework would be beneficial research for the education sector to explore the efficacy of a game-based, real-time prototype. Game elements and virtual learning environments in education have grown in use over the years, as newer generations of students come into schools with preconceived knowledge on how to interact with the medium[5],[6]. This study helps enable students and teachers to evaluate user opinions on designs through an emergent method, in an under-represented lens within product design.

1.1 What makes the framework novel?
There has been an increasing trend of product design research heading into the realm of VR. Whilst VR is an effective and immersive tool, the proposed framework exists within a game's engine - a 'platform tool'[7] - rather than a specific medium of hardware. The game engine is malleable, and the framework proposed can be edited to suit a designer's or researcher's needs, including incorporating the use of VR. By developing this abstract framework within the platform tool, the framework becomes more accessible and affordable to both designers and users, shedding the need of specific or expensive hardware or increased technical knowledge. Game engines have also begun to be used - and proven to be effective - for early design ideation, such as lighting in the automotive industry [8]. The framework

highlights the phenomenological experience of the user, and the design of the virtual environment through a gamified lens. Finally, the framework centres the user's *attachment* to a product, rather than focusing on how a user responds to a specific aesthetic quality, such as the recent study on product *form* design by Xing Lu and Suixian Yang[9].

2 GAME STUDIES: THE PLAYER EXPERIENCE

To enhance a game design perspective, this question is seen through the lens of game studies. One approach can be to explore retention mechanics in simulation games. Simulation games themselves offer a sandbox with little to no end goal, allowing the user to play and experiment as they desire [10]. These types of games, ones that offer the player interaction with key systems, yet with no enforced goal, allow players to express themselves fully and provide them with the widest variety of options [10]. By creating a non-linear digital environment for users to interact with, their experiences will differ per play-through, as will the perception of these experiences per player [11]. By acknowledging that each player may have a completely different experience within the open prototype, it can be a research aim to prepare data collection that would be constant. What interactions and mechanics will a player certainly perform, and how is it possible to track them?

2.1 Sustainable Innovation Through Digitization and Digitalization

An open-ended simulation could be considered as 'half-real' [12], incorporating a form of reality - the physical objects that the digital ones are based on. Utilising this framework could be more sustainable for designers developing physical-based products, particularly if those materials are expensive, pollutive or difficult to manufacture [13]. A digitized version could be prototyped and interacted with, allowing users to explore the product digitally, but with parameters that would simulate the physical world. This digital prototyping process can be more fast, iterative, and customizable than its physical counterpart - products can be edited in 3D modelling software or even within the game's engine in less time. This is becoming more frequent in select industries, even becoming a customer-facing service within certain fashion businesses [14]. The fact that this prototype can be replicated physically can showcase to students the effects of digitalisation. showcase how a digital framework can be more sustainable from a manufacturing, social, and iterative view.

3 METHODOLOGIES

3.1 Abstraction: Designing Objects And The Environment

'Digital objects' can be a broad term. Work has already been done in differentiating digital object types, [2] but for the sake of this prototype, the digital objects in this study was simulated physics shapes. The design of the environment can prompt the user to explore the physics and materials of the object, through various lighting scenarios and forms. The approach was to develop an abstract prototype, as this reduced costs and time - the prototype only took two days to create. An 'Abstract Prototyping' methodology allows one to examine how the framework may be developed and changed for the future, but it's also easier to present and evaluate key concepts[15]. This led the object designs to be simple primitive shapes, with different materials assigned to them, which reacted differently to the lighting in the environment.

3.2 Multimethod Research

Through using multimethod qualitative research [16], this pilot study conducted a usability test in the form of a digital prototype, followed by an in-depth interview. The prototype also collected a small amount of quantifiable data which then enabled the interviewer to ask customised questions. This method was chosen as the data sets could be easily triangulated to evaluate the effectiveness of the prototype framework. The research was conducted through a phenomenological lens, due to the concept of phenomenology, and the uniqueness of the player's experience being so intertwined [17]. Four users in total took part in the study, and their personal data was anonymised. Users were aged 22-31, with varying degrees of gameplay experience, yet all knew at least how to navigate in a digital, first-person environment.

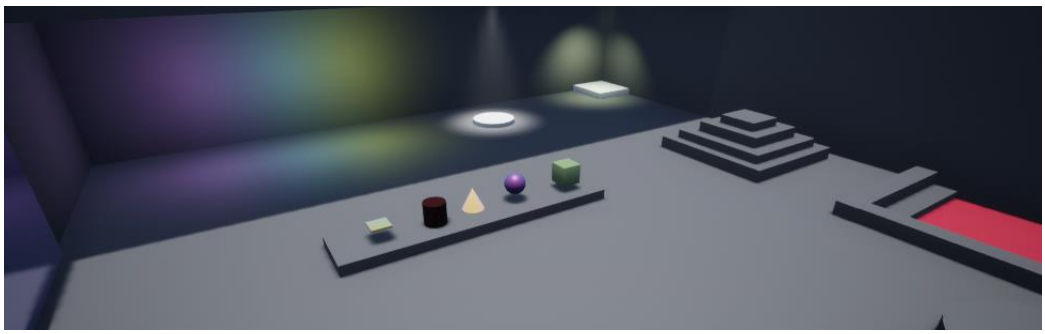

Figure 1. The layout of the prototype environment

3.2.1 Prototype Usability Test

First, the user played a prototype experience. The prototype was designed in Unreal Engine, and incorporated a sandbox-style playground, with a row of interactive objects in the centre [Figure 1]. These objects were able to simulate physics and responded when the player picked them up with the mouse button. They could be held, moved around and placed within the level. Before they began, each user was told that they must focus on and examine the objects in the space and do whatever actions they want to them. In Fig.1, there is a red zone; The users were told they could dispose of the objects if they would like to, and the objects would be removed from the level. They were finally told that this experience is a sandbox with no end goal. They were then free to play the experience. After they confirmed that they had examined each object comfortably, they could finish. Two sets of data were collected during this test - Observation notes made whilst users were playing the experience, and in-engine data collected afterwards. The in-engine data showed how many times users picked up each object, what time they spent in proximity to each object, and what areas of the level they spent the most time in.

3.2.2 In-depth Interview

During the interview, initial questions were asked to each user, starting with them ranking which objects they felt attached to, from most to least. After that, they were asked to elaborate on their reasons why. They were then asked about their thoughts on areas in the level, and then their thoughts on the amount of time they spent with each object. The small subset of quantifiable data from the play experience, combined with the notes made whilst the user was with the prototype, formed a background to ask more custom questions in the interview stage afterwards, such as, *'Why do you feel you spent the most time near this object/area?'* The interview data was triangulated with the two sets of usability test data to evaluate the user's attachment to the digital objects.

4 RESULTS

The abstract prototype software ran successfully with no errors for each participant. Each participant was observed examining the objects and the play space, and due to the non-linear design, were able to express themselves in various ways. Common themes were found amongst each participant during the usability test - each participant gave themselves a goal to perform in the sandbox. It ranged from building a structure, to placing objects into areas they felt belonged the most. Users tended to explore how the physics of the object interacted with the environment, yet that may not have been the most important factor for some when it came to ranking the objects they felt most attached to. When asked to rank how attached they are to the objects, each participant put the cylinder last, but for different reasons. Some said that they didn't like how it reacted with the environment, whilst others didn't like the colour of the material. Three out of four users ranked the cone as the item they're most attached to. When asked to elaborate, users had different reasons, ranging from they liked how the object moved when picking it up, to the colour of the object being their favourite. In every single case, the objects that the users spent the most time in proximity to was not their highest-ranked choice. When looking at data on how often users picked up each object, it did not correlate to the object that they were most attached to. However, participants tended to pick up the object they had ranked last the least. By asking customized questions, users stated that they appreciated different areas of the level according to their personal preference and if those areas helped enable their own set goal. For example, one user wanted to build a structure using all of the objects and chose to do that in the spotlight zone due to it having a podium and interesting

lighting. Two users disposed of objects, with one user disposing of four out of the five objects during their play session. When the user was asked why they disposed of so many objects, they stated they wanted to see what would happen. Even when told that this digital environment was a sandbox, due to being an experienced gamer, they wondered if disposing of the objects would solve a puzzle or change the objects in some way. Each participant spent at least 3 minutes minimum in the virtual environment until they felt comfortable that they had examined each object.

5 DISCUSSIONS AND REFLECTIONS

5.1 Key Findings: object attachment through experiences in a digital sandbox

From the in-depth interviews and observations in usability tests, players developed their own non-linear methods of experimenting with the objects in the play space. Through their preferences, users tested the object using the mechanics of the environment, and the tools given to them. Although abstracted, users had enough elements to interact with the object through their preferred methods of observation. Players trended towards viewing the objects that they were most attached to through either a haptic or aesthetic lens - focusing on how the object looked, or how the object responded to their inputs. No objects made any audio output or were deformed when thrown. By providing users with agency in a digital sandbox, they were able to comfortably explore objects through their unique lens of player experience. Although they may have had different reasons for their rankings, participants' objects that they were most and least attached to were almost exact, with one deviation. The user's previous experience with gamified experiences influenced how they approached the task, with one user attempting to break the sandbox with the objects to 'find a hidden door'. Another user, who has less gameplay experience, tended to struggle picking the items up, and approached the examination with a more hands-off concept - by placing items where they felt they fit aesthetically in the environment, not considering the physics of the objects at all. The small amount of quantifiable data gathered was certainly helpful in questioning and exploring player choices, such as asking why they picked up an object so many times if it wasn't the one they were the most attached to. This has been noted by studies on product attachment - that just because a user engages with products and is positively stimulated by them, does not mean that they will become attached to them [1].

5.2 Using design tools for triangulation: Kansei Engineering

As the design of the virtual environment is abstracted, it is possible to apply various design tools such as Kansei engineering, for triangulation depending on what data we would like to adjust and gather. Kansei engineering is a process that aims to centre the targeted user's thoughts and feelings into the design of a product [18]. The process has an overlap with games design, as the core premise of designing games is requiring a user's interaction with a system, and focusing on how they respond to the product [19]. It is therefore possible to apply Kansei engineering to deconstruct user's thoughts and feelings and categorize them accordingly. Such a method was used by X. Liu and S. Yang when exploring product form with VR models [9], although in a more quantitative way. They created quick-form questionnaires after a user has reviewed a 3D model virtually and utilized that data as part of a Kansei engineering exploration. It is possible to explore a similar approach with the proposed pilot study, to gather qualitative data such as a user's thoughts and feelings during the process due to the gamified nature of the framework.

5.3 Promoting Global Cross-Disciplinary Collaboration In User-Focused Design

Broadly speaking, digitization is recognised to be very important in many countries. It offers ways that countries can collaborate with each other in a faster and easier fashion than they have previously [22]. Digital objects can be transferred faster and more sustainably than their physical counterparts, allowing global collaboration on digitized designs of their products. By utilizing a digital prototype, it is possible to promote a faster, easier and more sustainable method of collaborating. Students can be encouraged to work with other countries and disciplines as the framework can be edited to suit more specific needs, such as examining a user's attachment to a certain material of the object, or how the object responds audibly. The issue with digitalisation is that a baseline of equipment is needed to contribute, and marginalized regions may not be able to provide those specific needs. It may also be easier to find specific users to interact with the framework as the entire process can be performed digitally, with the researcher examining the gameplay through screen-sharing tools. Users would need specific equipment

that allows the prototype to be played. This framework can promote environmental sustainability when collaborating, as it removes the needs for users, researchers or designers to travel geographically [23].

5.4 Educating Newer Generations

In regard to education, this form of methodology would be useful in showcasing how the gamification of usability tests lends a unique insight into object attachment. Students may want to examine this methodology due to its 'gamified' lens and would be able to easily grasp concepts due to their pre-conceived experience with a virtualised culture [20]. As game design can be a unique and emergent medium within product design, students may want to experiment with a different design lens than they are used to. However, due to the abstracted nature of the prototype, other design theories could be applied, such as Kansei engineering. Educators can showcase new, unique, and relevant product design processes that tackle rapid prototyping development and consumer-orientated innovation which are important for companies to produce [21].

5.5 Limitations

Whilst four participants felt like an adequate amount for such a qualitative pilot study, there wasn't a diverse range of age and previous gameplay experience. The one user that had less gameplay experience interacted in a radically different way from the others, as noted in the results. Previous game experience can have a large effect on how the user interacts with the object in a digital space, and this should be investigated within further studies. Utilizing quantitative data was very beneficial for asking in-depth interview questions, and whilst there wasn't a lot of correlation between the in-engine data and ranking of object attachment, this could be explored in a wider-scale study. Deploying and researching the use of emergent media such as game engines within prototyping and product design is under-represented, due to the multidisciplinary nature of games studies itself. Further research is needed on exploring product design through a game's studies lens. There is a lack of research measuring whether user attachment to a physical object and their digital counterparts are identical which should be explored in further studies, although it has been found that virtual products are more effective at communicating a product than text or image, inside VR, and viewing 3D models through a desktop [9], [21].

6 CONCLUSIONS

The findings from this study can influence methods of evaluating user object attachment, through a new, emergent and underrepresented lens. Each user's play experience with objects will be unique when presented in a non-linear digital environment. The findings show that users may set their own goals if presented with none, when given a task of examining objects. The study demonstrates that by using a game engine, (or other real-time digital environment) it is possible to measure effective parameters which would not be equally feasible in a physical space. This can help to open the field up for future quantitative studies or enable researchers to go more in-depth with their qualitative research. The data indicates that object attachment can be evaluated in a digital space, particularly when triangulating qualitative data. This framework has supplied an example of how it may be used in an educational context, by providing a new abstracted framework that designers can establish their products within. Educators can also explore and evaluate digital interaction with their students through this prototype, from a new perspective. They may also be able to apply product design methodologies and other design theories on top of the prototype to teach and discuss them in a new fashion. Additionally, the framework has showcased how it can be used to promote a more sustainable method of prototyping and researching object attachment. The findings of this paper suggest that developing a virtual environment for digital interaction can be transformative and customizable according to a designer's needs, and as this methodology was abstracted, it should be clearer how a designer can do so. The amount of varied data collected shows that placing players in a gamified digital prototype environment can be an effective way to measure object attachment, as users are encouraged to explore and play with designs. This pilot study on exploring a methodology through an underrepresented lens provided valuable new insight into the potential future of prototyping and evaluating object attachment.

REFERENCES

[1] Mugge R., Schoormans J. P. L. and Schifferstein H. Product attachment: Design strategies to stimulate the emotional bonding to products. *Product experience.* 2008, pp.425-440.

[2] Koles B. and Nagy P. Digital object attachment. *Current Opinion in Psychology* 2021, 39, 60-65.

[3] Burgess J. and Jones C. “I harbour strong feelings for Tali despite her being a fictional character”: investigating videogame players’ emotional attachments to non-player characters. *Game Studies* 2020, 20.1.
[4] Watkins R. and Molesworth M. Attachment to digital virtual possessions in videogames. Research in consumer behavior. 2012, (Emerald Group Publishing Limited.)
[5] Janssen D., Tummel C., Richert A. and Isenhardt I. Towards measuring user experience, activation and task performance in immersive virtual learning environments for students. In *International conference on immersive learning*, Santa Barbara, CA, June 2017 pp. 45-58. Springer, Cham.
[6] Alexiou A. and Schippers M. C. "Digital game elements, user experience and learning: A conceptual framework." *Education and Information Technologies* 2018, 23.6, 2545-2567.
[7] Foxman M. United we stand: Platforms, tools and innovation with the unity game engine. *Social Media+ Society*, 2019, 5(4), 2056305119880177.
[8] Ekströmer P., Wever R., Andersson P. and Jönsson J. Shedding light on game engines and virtual reality for design ideation. *Design Society: International Conference on Engineering Design*, July 2019 pp. 2003-2010. Cambridge University Press.
[9] Liu X. and Yang S. Study on product form design via Kansei engineering and virtual reality. *Journal of Engineering Design*, 2022, 33(6), 412-440.
[10] Juul J. Without a goal: on open and expressive games. *Videogame, player, text* 2007, pp.191-203.
[11] Sommerseth H. Gamic Realism: Player, Perception and Action in Video Game Play. In *DiGRA Conference*, Tokyo, September 2007
[12] Juul, J. *Half-real: Video games between real rules and fictional worlds*, 2011 (MIT press).
[13] Holmström J., Liotta G. and Chaudhuri A. Sustainability outcomes through direct digital manufacturing-based operational practices: A design theory approach. *Journal of Cleaner Production*, 2017, 167, pp.951-961.
[14] Geczy A. and Karaminas V. (Eds.) *The end of fashion: Clothing and dress in the age of globalization*. 2018, Bloomsbury publishing.
[15] Opiyo E. Z., Horváth I. and Vergeest J. S. M. Abstract Prototyping of Design Support Tools: Methodology and Preliminary Results. *International Design Engineering Technical Conferences and Computers and Information in Engineering Conference* Vol. 19715. Nevada, September 1999. (American Society of Mechanical Engineers,)
[16] Mik-Meyer N. Multimethod qualitative research. *Qualitative research*, 2020, pp.357-374.
[17] Čulig B., Katavić M., Kuček J. and Matković A. The phenomenology of video games: how gamers perceive games and gaming. *Engaging with Videogames: Play, Theory and Practice* 2014, (Brill, pp. 65-75.)
[18] Nagamachi M. Kansei engineering as a powerful consumer-oriented technology for product development. *Applied ergonomics* 2002, 33(3), 289-294.
[19] Tekinbas K. S. and Zimmerman E. *Rules of play: Game design fundamentals.* 2003 (MIT press).
[20] Alexiou A. and Schippers M. C. Digital game elements, user experience and learning: A conceptual framework. *Education and Information Technologies* 2018, 23.6, 2545-2567.
[21] Jasper J. *Virtual Reality-Based Product Representations in Conjoint Analysis, 2015.*
[22] Haefner L. and Sternberg R. . Spatial implications of digitization: State of the field and research agenda. *Geography Compass*, 2020, 14(12), e12544.
[23] Chen X., Gong L., Berce A., Johansson B. and Despeisse M.. Implications of virtual reality on environmental sustainability in manufacturing industry: A case study. *Procedia CIRP*, 104, 2021, pp. 464-469.