Objects that make us feel: Exploration of affective designs across digital and physical platforms.

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Abstract

This research addresses the issue that we as a species are facing where one of our vital senses are being left behind as the rate of development of digital technologies increase. Visual and auditory dominance in multi-media entertainment has left out tactile stimulation in the race to perfect the digital experience.
The connection between the digital and material world is explored in this research through 3D design and fabricated through 3D printing, clay modelling and brief experimentations with photogrammetry and high density foam.

The research follows a practice based approach where I let my designs guide the research process. One design lead to the other, beginning from a physical clay artefact and traveling to a digital 3D space where it takes various forms and it re fabricated through 3D printing to be assessed and tested, which leads to the next variation. The aim was to design the act of holding hands into an object with the goal to bring out affective responses from the use. Moreover, the contribution to a persons wellbeing by reducing stress through these designs are reviewed.

The results showed that by adding an affective element that can shock, awe, bewilder, or dazzle the user, in 3D printed designs, contribute positively to the emotions of the user, which can have a major significance on a persons long term well being.

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Attestation of Authorship

"I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgments), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning."

Student Signature: ______________________________

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Introduction

Social media and the love for all things digital have blurred the lines between the material and virtual worlds. This brings tremendous opportunity for the exploration of a new sensory stimulus that bridge these worlds and bring pleasure to peoples lives, hence promoting wellbeing and higher levels of productivity. This project is focused on the sense of touch, which has been recognized as being "fundamental to human communication, bonding, and health" (Keltner, 2010).

The hand has been proposed as the organ of touch and called "a persons outer brain" (Peck & Childers. 2003).Purcell, 1984 (as cited in Helander & Khalid, 2006) states, emotional responses to objects are greater if the object is different from what is expected. A pat on the back for performing well at the workplace can boost the morale of employees. Since this is not a regular occurrence, it may come off as a surprise and add positively to the emotional state of the employee.

Happiness in this study, is not looked at as a goal but a direction. A journey out of which, many other positive effects may come. Specifically, from a design perspective, a more consciously designed object can have positive effects on the user (Villani et al., 2018). The goal can be as simple as the reduction of stress by making everyday objects subtly interactive or playful. This is not proposed for medicinal or therapeutic benefits, but as a play on "autotelic touch". A persons NFT (Need For Touch) may be instrumental (for functional purposes) or autotelic(for sensory feedback). Autotelic touch involves exploratory touch or playful touch, which is prevalent in differing levels in every individual (Peck & Wiggins, 2006). Instrumental touch as stated by Peck & Wiggins (2006), is a customer high in instrumental touch, feels a sweater to learn if the material is thick enough to provide warmth. They add, that it is a rational information gathering through tactile engagement, where autotelic touch would be more enjoyable. An experience that is more hedonic than instrumental.

The initial aim of the project was to reduce everyday stress through conscious design in simple objects while retaining their utilitarian features. These designs were created digitally as my knowledge and experience in Visual Effects and 3D modelling helped me create and modify various designs with relative ease. This approach presented an opportunity to explore the relationship between digital and physical worlds, to better understand how touch plays a part in material exploration and creates a sense of wellbeing. The aim of this research was to explore the transference and relationship between the digital and the physical "worlds", investigating ways in which the design of everyday objects can be reexamined through contemporary and creative design methodologies which focus on emotional and sensory stimulation.

Introduction

It was intended for the designs to enable unique experiences, different from ones with regular artefacts, and ultimately be more engaging. The limitations of 3D printing has been discussed in this study and its influence on the creative process and the design challenges presented to the designer.

This study will approach 3D printing from an artistic perspective to realize its potential in contributing to the field of art and design. While 3D printing can be used to print a variety of objects, this research focuses on everyday objects that are found in common places (i.e. offices, homes) that people regularly have to interact with. These objects were recreated with new forms or features to present new and viable physical forms from digital artefacts for expressing affordances, or social presence of interactions.

Digital media has overwhelmed our visual senses through movies, video games, advertisements, social media, etc. Our bond with the material world has diminished, and society is deprived of haptic stimulation today. In this Masters research I attempt to reconnect ourselves with our tactile senses through design and increase awareness of the role of touch in contributing to our wellbeing.
Affect is translated into design features that produce an unconventional yet familiar sensation when incorporated in a cup, which was the base of my design experimentation.

In this study the element of surprise was found to be a key aspect in designing affective interfaces. As people like surprises that positively contribute to their emotions and ultimately, their wellbeing. Positive affect results in increased dopamine release in the brain (Helander & Khalid, 2006, p.546), which is the hormone that dictates our mood. It was found that mild positive affect integrated as design features in objects like a cup, increased engagement and contributed positively to the mood of the user. The unusual aesthetic of the cup piqued curiosity and made the experience engaging and playful. These experiments can be further extended on to other objects by redesigning them for hedonic pleasure with a goal to maximize comfort and engagement.

Chapter One: Literature Review

1.1 Introduction

In this section the shift of attention from the physical to the digital world is considered in terms of its development and implications on designers. The review also addresses the significance of the material world and how it should not be neglected in search for the best digital experience. We have been overwhelmed by visual and auditory stimuli for a long time and there is still only limited research into other human senses, such as touch. The project emphasizes the need for hedonic values in design, and its contribution to wellbeing. We all have emotional responses to objects and design has the power to manipulate these feelings. Which, designers should use responsibly to help create engaging designs that are enjoyable and also functional. Happiness through such enjoyment has a direct effect on a persons wellbeing. The aim of this study was to create designs that had an affective element that is engaging and alleviates stress in human beings.

Digital technologies have advanced more rapidly than any other innovation in human history (United Nations, 2020). As the world adopts a more digital mindset, there is an enormous opportunity for designers to push themselves to create a better world. However, I believe that the physical world should not be left behind in the endeavor to create a better digital experience.

The dominance of visual and audio senses, first proposed by the philosopher Aristotle in the 4th Century BC (Gregoric & Fink, 2022), continues to drive research into perception (Hutmacher, 2019) and communication systems. This is particularly evident in technological interfaces and product marketing. The magic of TV commercials and print media captivate our attention through imagery and motion pictures, informing our daily choices to a great extent. Screens have replaced shopping malls, theaters, concerts, offices and as these interfaces to digital technology become pervasive, the physical bond with our environment is changing. (Bayseu, 2018). However, as human perceptual systems evolved to detect sensory cues in our physical environment, the ‘proximate’ senses - smell, taste and touch, can still have a powerful effect.

“It is not true that people do not care much about the materiality of things. It was found that people do care about materiality in their experiences with everyday things and associate diverse meanings to their perception and appreciation of material qualities.” (Jung & Stolterman, 2011. p.155).

1.2 Touch

A study conducted by Peck and Wiggins (2006), showed participants who were high in ‘autotelic’ Need For Touch, NFT (need for exploratory touch) or, a higher need for tactile stimulation, had increased persuasion towards a product with a touch element incorporated in its packaging. Regardless of the congruence between the touch element and the message. In short, the participants were given multiple products to interact with, to assess if a touch element in the packaging would persuade them to purchase the product. It was seen that the participants who enjoy exploratory touch or are more inclined to touch (autotelic NFT) had higher levels of motivation to purchase the product even if the tactile element and the product were not related, hence proving their hypothesis. For example a printed element with no-touch features compared to a printed element with textures or furry touch attributes (positive sensory feedback) were seen to have a higher success rate with persuasion in the participants. Every individual has NFTs at differing levels. There are autotelic and instrumental NFTs. Instrumental NFTs deals with the need for utilitarian touch (for example checking the weight of a piece of fruit to get an indication of its freshness). People who are high in autotelic NFT often feel an irresistible need to engage in exploratory touch and their focus is on the sensory aspects of touch. Those who derive pleasure from touching objects for its sensory feel are high in autotelic NFT. (Peck & Wiggins, 2006, p.57). The authors also noted that we live in a tactilely deprived society and chances to freely experience the material world firsthand are diminishing.

“Touch is an almost irresistible urge for children and adults alike” (Peck & Wiggins, 2006). Touch is one of our primary senses however, the focus on touch over the history of industrialized product design seems to have been fixed on utility and ergonomics. Touch plays a vital part in hedonomics, and an important role in shaping our understanding of the environment from birth. Hancock et al, (2005) states that hedonomics is a comparably fresh discipline, where much research is yet to be done.

1.2 Touch

On a visit to the Auckland Museum in April 2022 there was an abundance of evidence to support this theory of touch and how it creates a more intimate engagement with the audience by considering affect and emotion in the design of the experience. Beyond the artefacts on display there were many activities that involved touching to learn and to understand., An example of this would be the native bird's section where upon pressing a large round wooden button, the birdsong corresponding to the button would play. It was the smooth sensation (sensory feedback) of pressing the button that had a captivating effect on the user and encouraged them to engage with the buttons more due to its hedonic effects, with an outcome familiarizing and educating them with the sounds of New Zealand's native birds. This shift in museological display from artefacts presented in glass cases to be seen but not touched to interactive displays, parallels the comments of cultural historian Constance Classen: "We in the modern West need to be reminded that we are not just creatures of the eye, we are full-bodied beings with the capacity to learn about the world through all of our senses. In an era of 'virtual reality', where life often seems to be limited to what takes place on a screen, … other sensorially aware cultures offer a timely lesson about the importance of recovering the multiplicity of sensory experience in our lives." (Classen, 1999, pp. 278–279). Nowadays, technologies are screen heavy. Designers are integrating affect with digital user interfaces to compensate for the lack of physical stimulation which human beings very much need and learn through. Minimalistic, functional designs are perceived to be convenient, but humans as a species cannot ignore the need for physical touch/ stimulation. The lack of haptic features could be a cause of stress in individuals who tend to be autotelic in nature.

> It is clear that many designed objects and environments are silent companions in our daily lives. We are surrounded by them in almost everything we do and we interact with them intentionally and unintentionally. In this respect, studying the potential of design and environments to enable people to work on their happiness holds great promise for creating a better world (Petermans & Cain, 2019. para 7).

1.2 Touch

In summary, digital technologies have grown exponentially in the recent years and as our attention gets absorbed to the digital world, we must not lose contact with our physical environment. The dominance and the role of visual and auditory senses in product marketing to capture our attention has been evident since ancient times. It has been stated that we live in a society deprived of tactile stimulation which may have negative effects on peoples' emotions. This study emphasizes the need for hedonic values in design as the primary focus has tended to be on utility and ergonomics. It's an irresistible urge for human beings to touch (exploratory or playful touch) as it plays a vital part in shaping our understanding of the environment and contribute to our wellbeing.

According to Classen (1999), humans require physical stimulation as a lack of haptic feedback could be a cause of stress, specially in people autotelic in nature. This research aims to create designs that demonstrate higher and differing levels of tactile response with the intention to alleviate stress through affective design features.

1.3 Affect

“Affect is said to be the customers psychological response to the design details of a product” (Helander and Khalid, 2006. p 544). A positive, neutral or negative response is what one can have. Positive affect has the potential to contribute to the happiness of people, which as a result regulates a person’s wellbeing.

The terms wellbeing and happiness are often used interchangeably.

> Etymologically, “well-being” is derived from the Latin verb “velle”, meaning to wish, will or literally, “to be well”. As was mentioned earlier, no universal or specific definition can be given. However, most researchers agree that the concept has distinctive components: an affective part that has its evaluation based on emotions and feelings, a cognitive part that relies on memories, stored information and barometers based on expectations upon life quality and a contextual part, that relates to the context proper to all individuals. (Petermans & Nuyts, 2016. p.3).

Subjective wellbeing is concerned with individuals’ subjective experiences of their lives and is used synonymously with wellbeing (Diener, 2009). Designed products, environments, and services are not only to be considered as a “feature” of our circumstances, but also as a ‘platform’ where or with which, people can set up intentional activities that contribute to their happiness (Petermans & Cain, 2019).

In this Master’s research there is an assumption that emotion, affect, happiness and wellbeing are interconnected and complement each other in ways that go deeper than facial expressions and body language. Emotion dictates how we feel, think and behave. It is the design features of tasks, artifacts and interfaces that bring out affective reactions in people and operate either through the perceptual system (looking at) or from a sense of controlling (touching and activating) or from reflection and experience. Hedonic Well-being, originated from the ideas of Greek philosophers Aristippus and Epicurus. Their viewpoint was that the goal of human life is to experience a maximum amount of pleasure, which was nuanced by Epicurus as a life in absence of physical pain, fear and mental disturbance (Petermans & Cain, 2019). Research on hedonic values and seductive interfaces is a contrast to the focus on safety, function and productivity that has dominated human factors and ergonomics. This study engages playfully with the ideologies of Epicurus and Aristippus – focusing on hedonic values - in the field of design. “Things are said to be fun when they attract, capture and hold our attention by provoking new and unusual perceptions or arousing emotions. They are fun when they surprise us and present challenges as we try to make sense of them” (Helander & Khalid, 2006. p.544).

1.3 Affect

Stress, as a reaction to how we feel when under pressure, or threatened, is experienced by every organism in the world at different levels. Stress, does not instantly have drastic or lethal effects but can amount to it over long-term exposure if left unchecked. We may experience stress anywhere, from our homes, workplace, and outdoors. Long-term stress can affect an individual and make them less productive in their daily lives and can also lead to health complications. Whereas individuals with lesser levels of stress, are often happier and better able to benefit society and communities. The aim of this study was to explore designs that alleviate stress through hedonic designs.

> From an economic point of view, happy people equal to successful people. Happy people are more social, altruistic and active. Happiness seems to promote people's capacity for constructive and creative thinking. Happy people not only feel better, more energetic and physically healthier leading to a longer life expectancy, but happy people are also more creative and open-minded, having better relationships and are more productive in their jobs. (Petermans & Cain, 2019. para 3)

Isen 1999 (as cited in Helander & Khalid, 2006), found that creative problem solving improves with mild positive affect. It aids in the recall of positive and neutral thoughts which systematically changes decision making strategies while completing tasks. During this time, the brain is said to release dopamine (which is the "feel good" hormone). Theoretically, as stated by Ashby et al (1999), there is an auxiliary increase of dopamine release in the mesocorticlimbic system during periods of mild positive affect (Helander & Khalid, 2006).
There is much research yet to be done on the relationship between affect and wellbeing. There is evidence of various theories that connect them but not much has been proven or experimented with. This study also investigates the effects of mild positive affect through design.

Stress management is broadly associated with being happy, as striving for happiness is striving to be free of stress, which has been known to be a silent killer and affects humans and animals alike. In humans, it hampers productivity and can have health complications if people are exposed to long term stress, making them less able to contribute to society as someone with lesser levels of stress. According to a study conducted by Cady and Jones in 1997, a 15-minute massage resulted in significant reductions in physiological stress in seated employees in an office setting, and therefore, presenting evidence of the vital role touch has to play in stress management and maintaining wellbeing. This points to a need for further research to prove this theory that affect and emotion incorporated in design can have positive effects on people and aid in stress management and wellbeing.

1.3 Affect

To summarize, we all have affective responses. They may be neutral, positive or negative. Positive affect is associated with happiness and wellbeing as these feelings are interconnected. Design has the power to drive affect in people. Examples of this can be through features in products (Ex: Fidget spinners), advertisements, video games (engaging games have the potential to make the players feel accomplished or very frustrated) to experiences in theme parks (roller coaster rides to haunted house experiences). Hedonic wellbeing has been around since the times of Epicurus and Aristippus who stated the goal of human life was to experience a maximum amount of pleasure. The concept of seductive interfaces and hedonic values is a fresh contrast as compared to current design trends that focus on safety and ergonomics, which is essential in certain designs like hospital equipment, machinery, etc. But there are plenty of areas where the designer can deviate from strict disciplined design to a more interactive or playful one. This study focuses on affective and hedonic features in objects in the discipline of design.

1.4 Emotions

“Emotions are often elicited by products such as art, clothing and consumer goods; therefore, designers must consider affect and emotion in design”. (Helander & Khalid, 2006). Human beings constantly interact with various objects. Most designs will elicit emotions in both the designer and the user, calling for initiative to control the user experience through intentional design effort. For instance, some people like to have stress-balls in the workplace. It is perceived to reduce stress, overcome boredom, clear their minds. The function of the object is simple, yet it yields surprising results. Engaging in such activities often help individuals cope with the pressures of daily life. This also reveals the existence of a need for products that deal with reduction of stress and focus-building through simple activities, designs and patterns, while justifying a demand among the population. However, it must be noted that just removing displeasure does not ensure a sense of relaxation and pleasure in products or objects. Kano (1984) identified the gap between utilitarian and pleasurable design features. According to him designs should have “must-haves” and “delighters”. As the name suggests, some expected design features are the “must-haves” and do not add to satisfaction, but merely avoid it. The unexpected surprising features, although not crucial to the functionality of the object are “delighters” and create satisfaction in the users. (Helander & Khalid, 2006) Similarly Faulkner and Caplan (1985) categorized product design using importance and satisfaction as well. For example, in smartphones, the functionality of the standard telephone is maintained and does not create satisfaction (we don’t buy phones based on how good the quality of the call will be) this feature is expected, however, an in-built forty-megapixel camera would be deemed as a delighter, or the ability to support high quality video games with ease would be classified as a delighter and this creates satisfaction.

Emotions have been recognized as important in product design. “In emotional design, pleasure and usability should go hand in hand, as well as aesthetics, attractiveness and beauty.” (Norman, 2004, p. 543). A sculpture made by artist Israel Hadany (Fig 1), demonstrates emotion and affect in one of his designs. Stemming from our childhood, we often associate the lap with comfort, which is a key feature of this artwork. The form of a seated woman (lower half) which integrates into the upper half of a chair, inspired me to create something similar that can be interacted with regularly. Furthermore, this piece draws out the autotelic urge to interact physically with the artefact as the dissonance created by the form surprises us while the functional aspect of the chair makes us want to physically engage with the object. The pencil boxes that I remember from my school days had subtle interactive features were more popular among the children than the regular pencil box. These features could be a magnetic lock or an in-built pencil sharpener or even just the physical form of a car, but the effects went beyond its utilitarian features thereby complimenting it, as well increasing engagement.

1.5 Design Exploration

Designers should not blame their tools for the outcome of their work; however, better quality tools can enhance the creative process an expensive brush would serve the same purpose as a regular brush. It is the tactile feedback from the brush, canvas and even the paint, that adds to the creative flow of the artist, aiding the design process and making it a pleasant experience for them and eventually the viewers.

Similarly, in this project the affective design features can be said to be the above mentioned “expensive brush”, as it would make interacting with the object more interesting than with a standard design. This concept can also be used to motivate people to make better choices. For example, a new oven might motivate a person to bake more compared to an outdated one. Increased interaction with the “nice” oven will in return teach the individual to bake. Whereas, one may feel frustrated to use old appliances.

Fig.1
Timahad, Israel Hadany - Sculpture of a chair and a woman integrated into one piece of artwork.

1.5 Design Exploration

“Design exploration” research, as defined by Fallman, explores how to expand the field of design outside of the current paradigms. Design exploration “often seeks to test ideas and to ask “What if?”—But also to provoke, criticize, and experiment to reveal alternatives to the expected and traditional, to transcend accepted paradigms, to bring matters to a head, and to be proactive and societal in its expression.”(Fallman, 2008).

If design has the potential contribute to the happiness of an individual, it should be taken into special consideration while making design decisions. There are specific products available in the form of toys like stress balls and other toys with similar “satisfying” features. Interfaces can be considered as a design feature in this paper. What if these simple design features were to be integrated into objects that one uses or interacts with regularly? Peters et al (2018) adds, every technology can deliberately or inadvertently impact psychological wellbeing. We tend to prefer a more playful/ interactive user experience. Human beings as we know, like surprises, or to break out of the monotony of everyday life. Neilson and Norman (2004) have mentioned one important challenge in theory as well as application is the design of seductive and fun interfaces. The functionality of an interface can be considered part of the usability of an object, but should not be the only focus in the design. The development of sensory interfaces are the focus of this research so regular interactions can be designed to be more positively engaging and pleasurable through deliberate design effort.

1.6 Digital and Physical

You and I are all as much continuous with the physical universe as a wave is continuous with the ocean.

— Alan Watts

We are heading towards a time where our digital assets will have more value to us than our physical ones. It can already be seen that people care about their digital presence and belongings. This can be seen with online tickets, a video game component, cryptocurrency, etc. The materiality of an object is described mainly through its tactility and visual perception. For example, a teddy bear will be perceived as cute, lightweight, smooth, and soft (associated with positive haptic and hedonic responses). However, objects can be associated with negative haptic and hedonic responses, for example a chalkboard is experienced as rough and screechy. This shows that people care about materiality in their experiences with everyday objects and associate diverse meanings to their perception and appreciation of material qualification. (Helander & Khalid, 2006).

This benefits the health and mind of the person, shapes character from birth and most importantly, has the power to calm one down under stress/ sadness (Eckstein, et al., 2020).

In cinema, there is a transference between the virtual and the physical. Not just a transference of imagery (being projected on a screen to being processed by the brain) but also a transference of emotion and affect, by empathizing with the characters on screen (Rushing, 2016). Similarly in this project, the transference of designs from the 3D workspace digitally to a printed physical artefact was explored, analyzed and observed along with the hedonic value of the designs at various stages.

1.7 3D Design and 3D Printing

3D design literally means three-dimensional design. It is designing of objects or artwork over three "axes" or dimensions (x, y, and z). 3D design technology has changed the world of cinema and video games. It has found its place in engineering and architecture. There are various applications of 3D in the healthcare sector as well as in the military, like firing practice in Virtual Reality and 3D models. (Bhagat & Chang, 2016). Everything that can be visualized or imagined, can be made in 3D software. However, the impact and sense of the game-changing effects and scope of 3D printing is still not well understood. (Redwood et al., 2017)

There are several digital tools and methods available to build 3D objects. Photogrammetry allows us to take multiple photographs of an object in the real world and create a 3D model on the computer with accurate results, or at least, a great starting point for modelers. This gives them a base model to start with, saving time and energy. 3D printing facilitates the designer to bring the form to reality by printing it using a plastic-based filament. This is especially useful for making prototypes for various kinds of designs for multiple disciplines. A wide variety of computer programs have been made to cater to 3D from different disciplines. Computers today are advance enough to facilitate these programs digitally in real time. The smooth operation of the program adds to the creative flow and helps the artist achieve the desired results on screen. For example, when sculpting, modelling, or painting digitally the designer can see the results of their actions in real-time. Slower machines can result in frustration in the designer. The screen becomes the canvas and smooth operation of the programs will ensure pleasurable goal accomplishment

> Recent advancements in parametric design, artificial intelligence techniques, design simulation and optimization have enabled computational tools to play an active, participatory role in the design process. (Kazi, et al., 2017).

This enables the designers to not only recreate existing designs, but to create completely new ones, allowing flexibility, and the privilege of being able to "undo" mistakes and refer to older versions of the design easily if needed. In this study we approach 3D design strictly from a designer's perspective, making aesthetics and "design features" the focus.

"Digital fabrication technology, also referred to as 3D printing or additive manufacturing, creates physical objects from a geometrical representation by successive addition of materials." (Shahrubudin et al., 2019). Additionally, it is the process of additively building up a part, one layer at a time (Redwood, & Garret, 2017). They further add that there are plenty of 3D printing technologies which have their own benefits, limitations and applications. "While design freedom is one of the strengths of 3D printing, Design for 3D Printing (or Designing for Additive Manufacturing) requires specific design rules that must be adhered to." (Redwood & Garret, 2017. p.182).

1.7 3D Design and 3D Printing

Though additive manufacturing offers great advantages over traditional manufacturing, there are limitations which keep it from becoming the solution to all manufacturing problems. On average a 1.5-inch cube takes about an hour to print in the additive manufacturing process which other methods may complete faster. This makes it unfit for large scale production and is the preferred methods when dealing with custom parts or low volume production runs. (Campbell, 2011).

According to Redwood, et al., (2017), 3D printing is best suited for “low volume, complex designs that formative or subtractive methods are unable to produce, or when a unique one-off rapid prototype is required”. This justifies the use of 3D printing in this study where the artefacts are assessed based on form, functionality, design features and aesthetics. These designs will not be mass produced; hence this method is most viable in producing prototypes for my design. It is further stated that additive manufacturing creates objects from the bottom-up by adding materials one cross-sectional layer at a time (Campbell, 2011). Like building objects and structures out of Lego blocks the design to print process begins at the CAD model (in most cases), which often comes from a sketch, concept, or a blueprint. This is exported into an STL file which is opened in a “slicing software”. This program converts the model into a code which is understood by the 3D printer which prints the design. In this research, 3D printing helped me produce sturdy designs from PLA (Polylactic Acid), a kind of polymer which retains and demonstrates the designed form perfectly. The limitations and challenges faced during this process are discussed later in this paper.

Industries like film, video games, architecture, healthcare etc, have been changed forever with the rise of 3D technology. This has broken barriers to design limitations and enabled designers to create any design that they can imagine. 3D has been used since the days of early cinema to create depth in films, which is adding a dimension (z axis) into the frame. 3D printing involves a very technical workflow, more suited to CAD modellers who like to work with precise measurements.

With the help of photogrammetry, designers can get accurate models of real-world objects. This process happens through multiple images of an object from all angles. Photogrammetry can save time in the 3D modelling process and give designers a base model to start with or use as reference. 3D printing is useful today for prototyping diverse designs. Nowadays, computers and computer programs have become advanced enough to run smoothly and offer the designer with a wide range of tools which aids them in the design process.

1.7 3D Design and 3D Printing

Digital fabrication or Additive manufacturing are the other names 3D printing is known as. Objects are built by depositing layers of liquid PLA or other materials over each other. There are various kinds of 3D printers, each having their own benefits, limitations, and applications. The process begins from a concept, exported into an STL file, imported into the slicing software which provides a code to the printer, generated by the provided model which prints the design. In this Thesis I created prototype designs by 3D printing with PLA (Polylactic Acid), which retains and demonstrate the designed form perfectly.

1.8 Holding Hands

The project started with the intention to create a design that is an interpretation of affective gestures in human beings. Hand-holding was chosen as one of those gestures that bring out affective responses from most people of all ages. This project explores affect on humans by incorporating design features which resemble the holding of hands as closely as possible through 3D modelling and printing. Holding hands frees up neural “bandwidth,” allowing the brain to focus on things other than potential dangers. This holds clues to everything from how humans evolved to how our brains have been shaped by natural selection to function. Holding hands can reduce activity in a part of your brain called the hypothalamus, which is responsible for regulating part of the body’s stress response, and the degree to which this is true corresponds with better general health and wellbeing. (Helander & Khalid, 2006).

In a functional MRI study, Coan et al., (as cited in Eckstein et al., 2020, p.5) found that holding the partner’s hand during the anticipation of pain reduced unpleasantness and bodily arousal as well as the neural threat response. The effects of hand-holding are deep and powerful in humans and primates, in this project it has been assumed that hand-holding helps reduce stress. The act of social allogrooming in primates is a similar concept. According to Dunbar (1991), the grooming process is more than just hygienic. It plays a role in maintaining social bonds within a group which promotes cooperation in primate societies. (Russell & Phelps, 2013). This act goes beyond the physical and affects our emotions. In addition, Eckstein et al., states all social mammals have tactile ways to create bonds and help each other feel safe. This instills a sense of calmness, security, and bonding all of which help human beings and other species feel intrinsic comfort. Touch has been suggested to be the key to beneficial relationships and an important function during bonding (Eckstein & Sailer, 2020).

1.9 Chapter Summary

We are losing contact with our physical and material world as we dive deeper into the digital reality that is becoming a major part of our lives. It can be seen today that people rely on social media for their social needs, money is becoming digital, purchases are made online, etc. The dominance and the role of visual and auditory senses in product marketing to capture our attention has intensified. But people today are becoming more aware of human impacts on their material environment. This study attempts to connect some of the dots between the material and the digital.

A study of autotelic versus instrumental need for touch proves the theory that touch has a positive effect on people who enjoy exploratory touch for hedonic pleasure (autotelic NFT) as opposed to people higher in instrumental NFT (touching for utilitarian purposes). Touch is irresistible to all human beings, but the focus till now has mostly been on ergonomics and utility. Touch plays a vital part in hedonomics, a discipline that facilitates the pleasant or enjoyable aspects of human technology interaction. Classen states the need for physical touch cannot be ignored. This study is essential as we as society are deprived of tactile stimulation and the chances to experience the physical world is diminishing. With the increase in population, pollution, unrest, and disease. The future generations may not have the world to explore and experience like we have till now. This study shines a light on the importance of hedonic values and features in design and how they contribute to wellbeing as a lack of it may be the cause stress in people high in autotelic NFTs.

Affect is defined as a person's psychological response to an object. Everything and every interaction brings out neutral, positive, or negative affective responses from us. Positive affect influences the happiness and wellbeing of a person. Therefore, we can say they are interconnected.
Design is a powerful tool to drive affect in people and can contribute to their happiness. Hedonic wellbeing has been around since the times of Epicurus and Aristippus, according to whom, the goal of human life was to experience a maximum amount of pleasure. Seductive interfaces and hedonic values are a welcomed idea as compared to current design trends that focus on safety and ergonomics which is essential in certain designs but leaves plenty of areas where the designer can deviate from strict disciplined design to a more interactive or playful one. My project focuses on hedonic features in objects in the discipline of design with the goal to alleviate stress by contributing to the subjective wellbeing of a person.

1.9 Chapter Summary

The consideration of emotion in product design has been becoming of prime importance to designers. Pleasure and utility should go hand in hand. Artists should not blame the tools for the result they achieve, as skill is greater than the medium. However, tools that are decent quality have superior tactile feedback which aids the artist in realizing their full potential while the haptic feedback smoothens the creative flow. Knowing that design has great power to contribute to the happiness of an individual, affect and emotion should not be ignored while making design decisions. Interfaces can be considered as a design feature in this paper. What if these design features were to be integrated into objects that one uses or interacts with regularly? The development of sensory interfaces is the focus of this research so regular interactions can be designed to be more positively engaging and pleasurable through deliberate design effort.

As we advance to a digitally dominant society, digital materiality is becoming a very real aspect of people's lives. We describe materiality through its tactile and visual perception and associate diverse meanings to their perception and appreciation of objects. This has benefits on the mind and health of people and shapes character. Most importantly it has a calming effect on people. Sometimes a tactile response is experienced by the body through visual stimuli. As in cinema, the audience embodies the character in the film and empathizes with them and even feels their pain. There is a transference between the physical and virtual worlds which facilitate the movement of emotions across the screen into our minds which influences us in some way. Similarly, the transference of designs from the digital workspace to a physical artefact was explored and studied along with the perception of emotion in the designs at various stages.

Chapter Two: Research Design

2.1 Introduction

The project set out to better understand the relationships between digital and physical artefacts. The research design involved an initial process of literature review and the identification of relevant work by other designers to develop a deeper contextual understanding of current theories and practices associated with the topic. This exploration prompted the second phase of the project, the development of prototype designs that interpreted affective gestures in human beings. Hand-holding was selected as one of those actions/gestures that bring out affective responses from people of all ages. Iteratively, through a process of experimentation, a series of prototype designs were developed utilizing a range of traditional and digital processes. This practice-led research was documented, tested, and reflected on. The documentation, observations, and analyses, along with the contextual research, were then written up in the exegesis.

2.2 Practice Based Research

As mentioned by Candy (2018), there are several different meanings for the term “practice.” A generalized definition would be “the actual application or use of an idea, belief or method, as opposed to theories relating to it.” It is also used to describe a frequent voluntary activity like practicing a musical instrument or a sport or a professional activity like practicing law. In the field of art and design, practice is a lifelong journey of the expression of creative instincts and desires as well as professional knowledge built over time, as a learning through doing, or practice. While research, on the other hand involves finding new knowledge, which involves the process of seeking and articulating knowledge. It is expected to produce something insightful, useful or, groundbreaking to be considered public research to be viewed and critiqued by anyone.

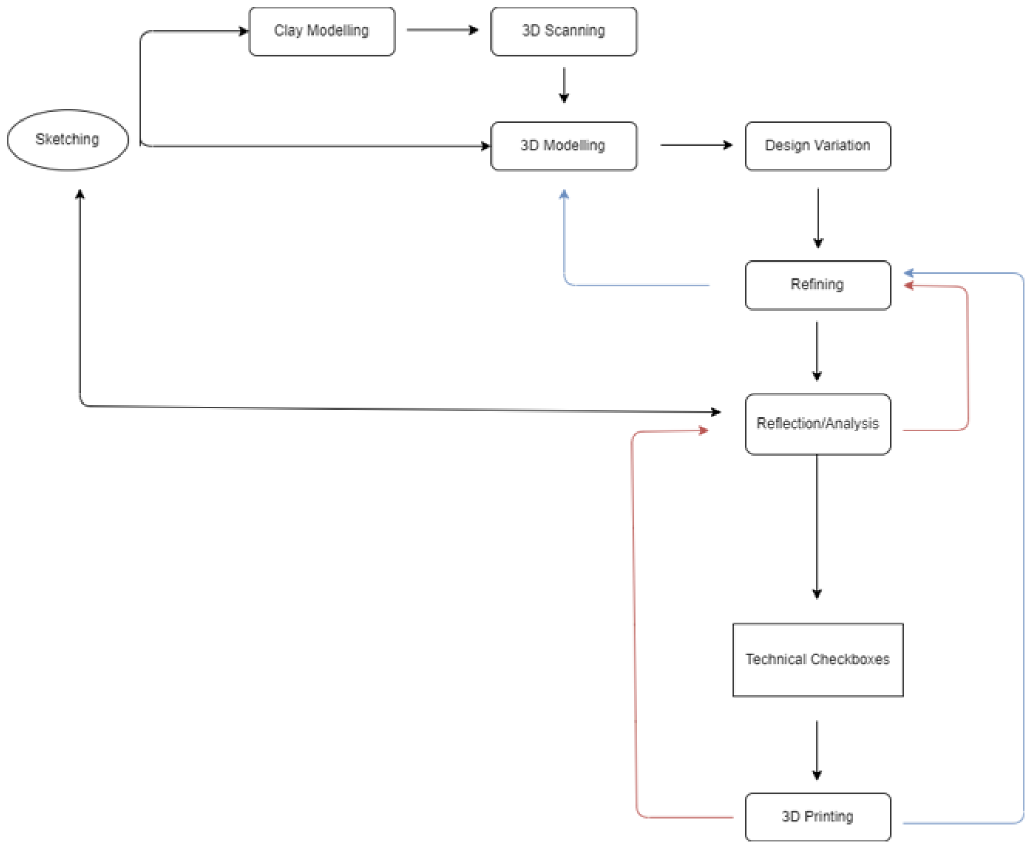
“Stated simply, practice-based research is an original investigation undertaken in order to gain new knowledge, partly by means of practice and the outcomes of that practice” (Candy & Edmonds, 2018).

In this type of research, the artifact is crucial to finding new understandings about practice. In practice-based research, the creative artefact is the basis of the contribution to knowledge. This method is applied to original investigations seeking new knowledge through practice and its outcomes (Skains, 2018). Practice and research work together to create new knowledge that can be shared and analyzed.

The project was framed by the theory of Affective Design (discussed in Chapter 1.4) and the methodological approach of research through design practice, or Practice-based Research (PBR). In this Master’s research I create and reflect upon artifacts through processes of designing, making, and prototyping to gain new knowledge or insight on the relationship between the flow of objects from the digital to the material world and the transference of affect through these mediums. In other words, the movement of the artifact through various mediums was studied along with the process which involved making using various mediums, both digital and physical. My own feelings, experiences and observations of the designs were also documented and analyzed
This study has the potential to contribute to an understanding of how an individual’s wellbeing is enhanced through conscious design decisions and the incorporation of tactile features that users can relate to, or something that resembles intimate and familiar experiences. There was a focus on experimentation with assorted designs, mediums and interfaces that can enable hedonic benefits through design.

2.3 Project Stages

Fig 2. Research design diagram.



The first design stage began with simple pencil sketches exploring basic forms of the designs. The aim was to introduce affective design features in everyday objects. For this, the object was required to be something that was used by everyone, every day. One of the first objects to emerge from an initial brainstorming process was a plastic cup. This object is available in every setting it serves a quite simple purpose and wears a simple design. This artefact thus fits this study well and the project focus was further refined to develop variations of this object and integrate an affective response by incorporating hand-holding in the cups design.

The features in themselves do not possess medical benefits but have affect or hedonic value where one simply (1) feels comfortable using the object, (2) it fulfills its functional purpose and (3) the look and aesthetics of the design and the materiality, intrigues us and encourages us for extended interactions with the object (Helander & Khalid, 2006). These kinds of designs can play a vital role in reducing stress levels at places like work and institutions.

2.3 Project Stages

The aim of the first prototype was to re-create or modify the standard cups exterior design to better fit the hand or feel better to hold by incorporating the "holding hands" concept to alleviate stress and make it a pleasurable experience. The design is supposed to simulate the sensation of interlocking fingers while interacting with a cup. It was an attempt to bring out a similar affective feeling while interacting with these designs as one feels when holding someone's hand. It is as if the cup reciprocates the feeling of holding onto you.

I decided to test multiple variants of just one affective gesture (hand- holding). These experiments were digitally conducted by creating models that conveyed hand-holding in different ways in a 3D software. These designs were translated into the physical world through both physical models and 3D printing. These prototypes were then evaluated by the designer on their hedonic and haptic qualities evoked by its use.

Fig 3. Plastic Cup used for prototyping

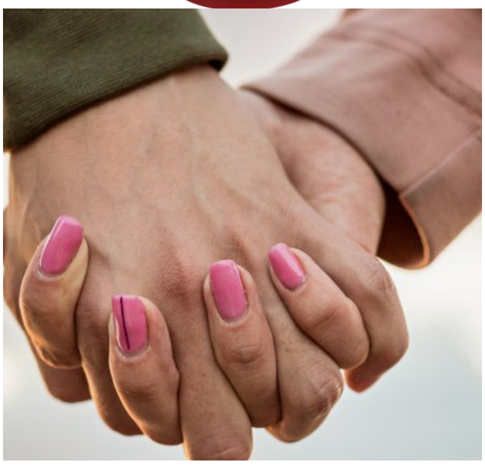


Fig 4 & 5 (Top) Handholding, or interlocking fingers.

2.4 Methods of Making

The methods of research through making involved a mixture of drawing, digital modelling, clay sculpting, 3D printing, a brief experiment with high density foam, and photogrammetry. These mediums were chosen as they fitted into the cycle of digital to physical making and offered a smooth and quick workflow to produce, replicate, and improvise my designs. These objects once fabricated were self-evaluated based on certain criteria discussed later in the paper. This process often led to the creation of new designs.

Maximum comfort and high engagement are the goals of these designs. Curiosity plays a vital part when it comes to engagement. Therefore, I attempt to create designs that surpass engagement driven by curiosity due to its short-lived nature. By bringing to reality what is created using technology, and vice versa, I also attempt to understand our perception of these designs.

Fig 6. Making with clay.

2.4.1 Brainstorming and sketching

The ideating, mind-mapping or brainstorming stage was the starting point for the project. Mind mapping was defined by Buzan (1993, pp.59) as an expression of radiant thinking and a powerful graphic technique which provides a way of unlocking the potential of the brain. The process crystallizes themes and ideas visually, radiating out from the main concept through branches to form a connected nodal structure (Ibrahim, 2013). Mind maps are also described as two-dimensional visual knowledge representations that show relationships among concepts or processes by means of spatial position, (Liu, Zhao, Ma and Bo, 2014)

This helped me figure out the direction of the project. It helped me in my project by bringing out all possible avenues I wanted to explore. Multiple approaches to designing was brought up in this process (*Fig 10*). For example, the direction of my design was laid out on paper. This included the physical considerations for the design (rings, grooves, etc) as well as the aesthetic decision. The making of these designs physically and digitally were also chalked down in the mind-map along with the intended emotions and gestures to be incorporated in the cup. Other objects that similar experiments can be conducted on were mentioned. This method helped me organize the information and plans I had, to create a clear research plan, being a guide, and helping me organize information.

“A ‘sketch’ tends to be understood as having a quality of being provisional or unfinished. It has become associated with the idea that it will generate further thought or ideas and is also seen as being able to ‘capture nuances of the observed world” (Lyon, 2020. p.298).

Sketching helped me visualize the concepts from the mind-map. As stated by Lyon above, sketches do not have to be a finished piece of artwork and is sufficient as long as it demonstrates its features or conveys the message clearly to the viewer. According to me, sketches have their own aesthetic that makes the viewer appreciate them. In my study it helped me not only create the designs originally intended, but also gave birth to many other variations digitally that were not planned in the mind-map stage. This was due to clearly being able to visualize the concepts in the sketch stage, and merge, add or take away parts to make new designs from the existing ones digitally.

Fig 7. Sketches of potential cup variations

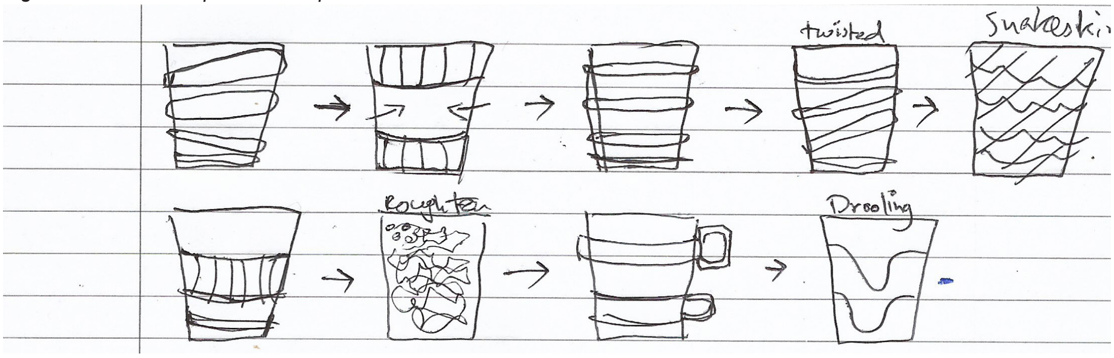


Fig 9. Sketches of features

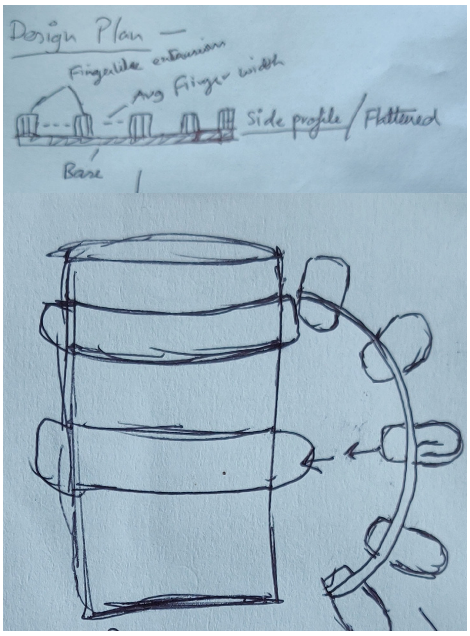


Fig 8. Sketches of concepts

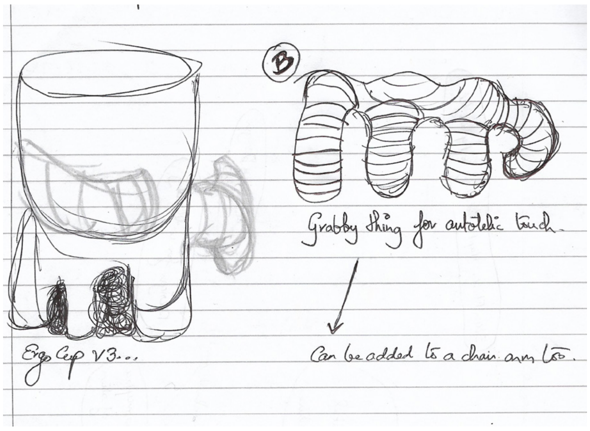
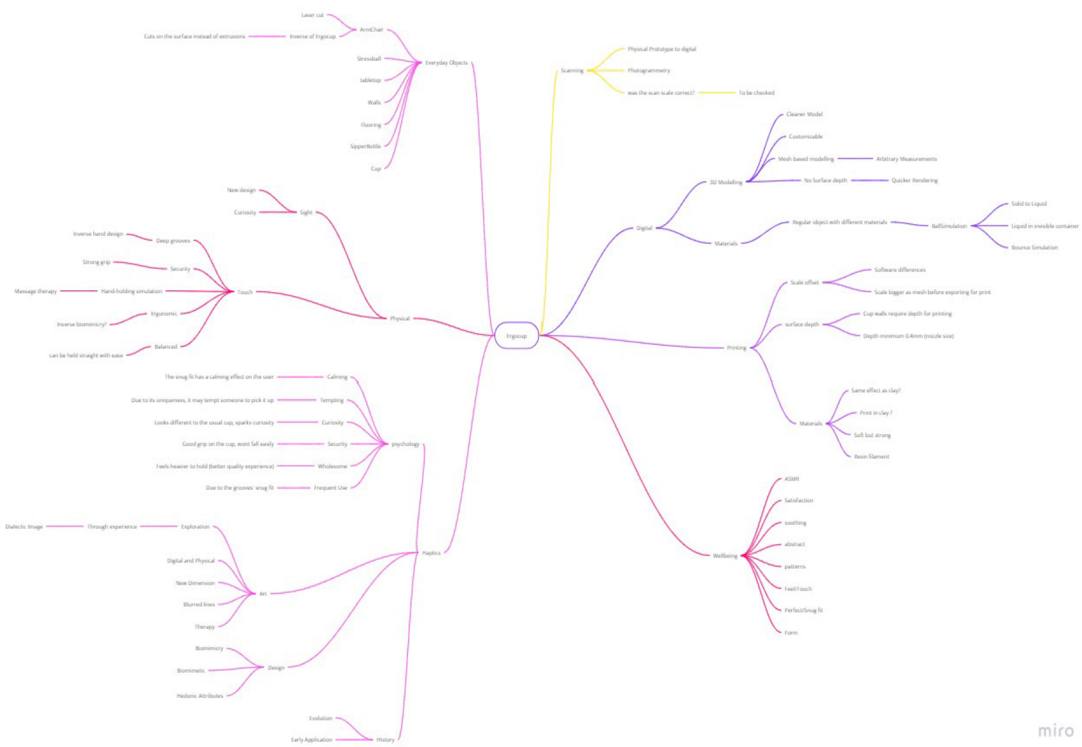


Fig 10. Mind Map



2.4.1 Prototyping

Prototypes are representations of a design made before final artifacts exist. They are created to inform both design process and design decisions. They range from sketches and different kind of models at various levels "looks like," "behaves like," "works like" to explore and communicate propositions about the design and its context. (Upcraft & Fletcher. 2003).

In this phase of the study, I had the key concept of hand-holding (affective/ hedonic element), sketches of the initial design with some variations (affective gesture incorporated in the cup), to start with. Due to the organic theme of the concept, I approached the prototyping phase by creating a physical model first. As the design is meant to feel. "Prototypes too often confirm that what we wish for is unrealistic or ill conceived" (Schrage, 1996). This shows how prototypes can serve to reflect upon one's own designs and help improve them. Upcraft and Fletcher (2003) mention that prototyping as a design practice is now promoted within the business community as a key element in innovation. Furthermore, according to Schrage (1996), shifting from "specification-driven prototypes" to "prototype-driven specifications" will have more innovative and unique results and no two prototypes are the same either in their making process or their roles in the design process. Therefore, I let my prototypes guide my design further to allow innovation of new and unique designs.

The first prototype I developed involved a disposable drinking cup. This was primarily because its large surface area had plenty of room to develop the desired features. The cup was marked according to the finger placements on the plastic cup with clay. The design was that of an inverse hand. Upon adding the clay bits to the cup, it was observed that the extrusions (inverse-fingers) on the cup required a specific height, and/or, depth for getting a better grip on the cup. This was tested by holding the cup while adding clay till the feeling was that of interlocking fingers. There was a total of four strips placed with a height (from the surface of the cup) greater than that of the fingers. There was also a sensation between the fingers from the design, which made a major difference in simulating that feeling. This could potentially be because that region of the fingers does not come in regular contact with objects and therefore feels good when it does get stimulus. The prototype instilled increased hedonic feelings compared to the original plastic cup. The next step was to scan the prototype and create a 3D mesh based on the prototype. This was achieved through a mobile application by taking multiple photos from all angles from which I was given a point cloud. This was brought into Blender (3D program) and recreated with a more refined look.

The creation of prototypes enables designers to test their designs for various accounts and make necessary changes. It helps the designer grow and develop as an artist, learning to reflect on, and critique his own work. A crucial step to my study as the designs will be best evaluated for affordance physically.

2.4.1.1 Clay Modelling

To take a clod of earth in one's hand and from this limp or inert matter to fashion an object that even remotely suggests something we love, is to feel that one is a genuine, if infinitesimal partner of the Great Creator (Putnam, 1939. p.5).

Putnam distinguishes the sculptor from the modeler in her book where she describes the modern sculptor as an artist that models in clay and never attempts the sterner medium of stone, which she argues is misleading for sculpture which means carving. The art of sculpting is subtractive, as one chisels away at the medium, which is not malleable like clay. Where modelling is an additive process to build clay models.

So, we can say that clay modelling is an additive fabrication process where the artist or designer uses soft mediums such as clay to create forms from a "lump of earth". Putnam emphasizes that all the world's greatest carvers from the Egyptians to Michelangelo, made their preliminary models in clay or wax. The medium of prototyping can have a strong influence on the whole design for example, the automobile industry has traditionally based the design of new models on mock ups done in clay that give a highly polished impression of how the finished product will look, but do not invite further changes. (Schrage, 1996).

Clay is described by Putnam as the "pleasantest" material to work in. Therefore, I chose to proceed with making my first prototypes with clay due to its deformability, and the hardiness of the final product. However, it is a challenge to keep the right consistency she adds. It needs lots of damp rags to keep the clay wet or it begins to harden in a few hours. (Putnam,1939). Since the design is based on an organic object, I wanted to first observe and test the basic imprint of the natural grip of the hand. By pressing onto a cylindrical piece of soft clay and restricting movement on either ends of the cylinder, I was able to make my interpretation of hand-holding or "interlocking fingers" in a design.

The resulting shape was familiar and is commonly used in the design of grips for walking stick handles. This prototype once hardened, felt comfortable to hold and had a snug fit. The cool temperature of the hardened clay and the smooth texture complimented by its natural hand-hugging design displayed potential for further experimentation which made way for further design variations mentioned later in this study. Something that was noticed was that there was increased engagement with the object even though it had no specific function at that stage.

2.4.1.1 Clay Modelling

Clay has been used for thousands of years as a building material and ease of use. This medium was best suited to my study due to its easy handling and is more forgiving than other mediums like wood or stone. Also, the softness of the clay would make modelling what I was after much easier and an organic process. Which not only provides me with my desired result but also makes the process an enjoyable learning experience.

Fig 11. Impression of the natural grip on clay (subtractive process)

Fig 12. Clay on cup (additive process)

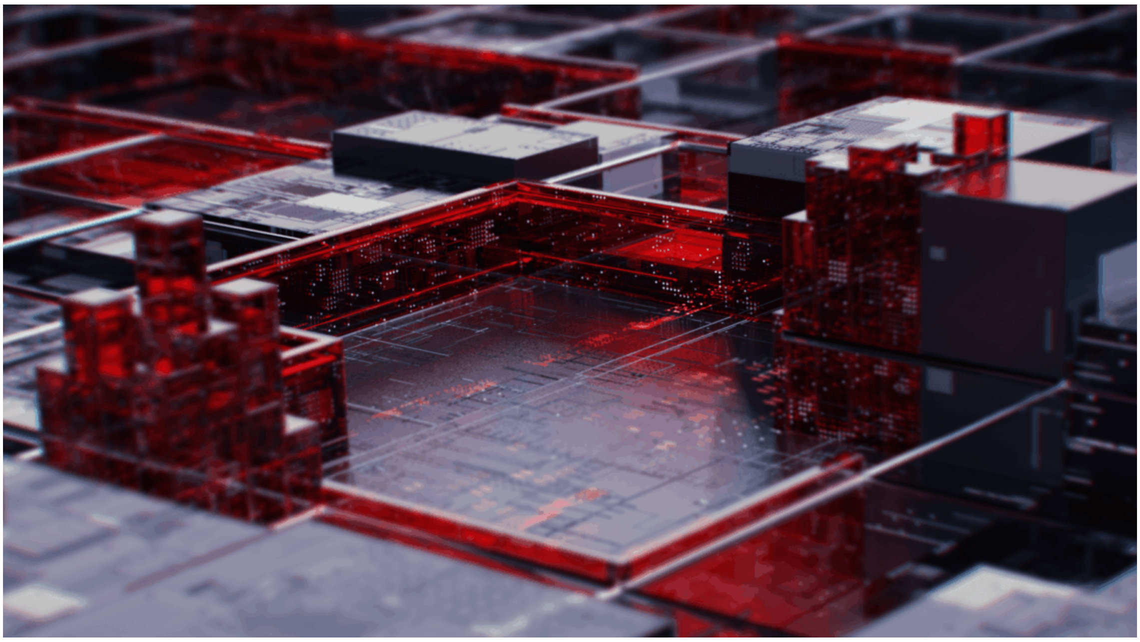
2.4.1.2 3D Design Prototyping

“3D design is the process of using computer-modeling software to create an object within a three-dimensional space. This means that the object itself has three key values assigned to it to understand where it exists within the space.” (Adobe, 2022) The key values mentioned above are the x, y and z axis, along which the designs are made contrary to the traditional 2D techniques where they are made along the x and y axis only. Therefore, 3D design can be said to be an object that is designed on 3 axes. The addition of the Z axis distinguishes 3D from 2D design.

“3D geometry is commonplace in computer graphics. Typically, this information comes in the form of depth and vertex positions, or normals and surface orientations”. (Nehab et al., 2005). In other words, normals or face orientation dictates which way the geometry is facing. This also gives the software an idea of the “inner and outer” walls of the mesh and is a crucial step to keep in mind for 3D printing.

Here I chose to design most of the research artifacts in 3D, as; firstly, my knowledge in 3D modelling would help me achieve the desired outcome without having to spend too much time figuring out how to make the object. Secondly, as is with any digital design, they allow us the freedom of saving files and undoing errors, which have heavier penalties in traditional making methods, and often not “un-doable”. Finally, it gives us the ability to create a form that can be translated into the real world, The form of the object is dictated by the imagination of the designer. Provided, it meets certain technical criteria when it comes to printing.

Fig 13. 3D Rendered image (Maxon. (n.d.). https://www.maxon.net/en/redshift/)



2.4.1.2 3D Design Prototyping

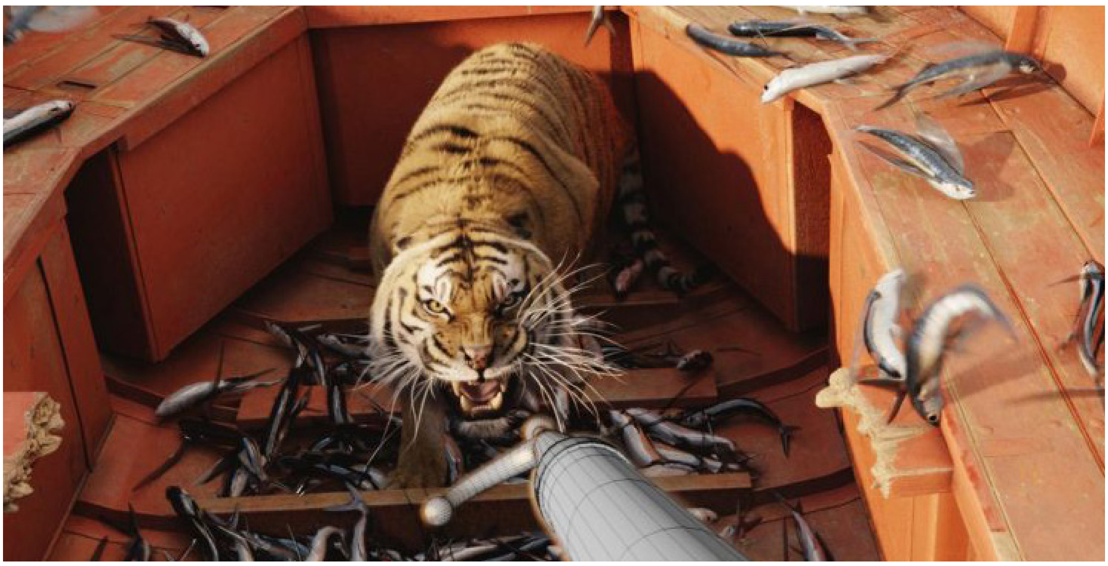
My experience in 3D design made me select mesh-based 3D modelling over CAD or 2D based approaches. This gave me the opportunity to utilize the 3D printers available to me, paired with my knowledge and understanding of clay sculpting, allowed me to explore this transference of mediums and artefacts. Which helped me achieve the desired design goals, while having a good control of the creative output. The 3D software I chose to go with was Blender, a powerful 3D software that is free to use for students and professionals alike. It offers and is not limited to powerful 3D modelling and sculpting tools.

> Blender is open-source software that allows a user to create high quality animations of 3D models and data. It has wide usage in the video game and entertainment industries. The software is also extremely useful for generating high quality scientific visualizations. (Kent, 2015. p.90)

Fig 14 3D imagery used in architecture visualization

Fig 15. CAD model of an electronic shaver (source: Google Images)

Fig 16. 3D tiger used in film. (Life of Pi 2012)



2.4.1.2 3D Design Prototyping

Fig 17. 3D model of tiger

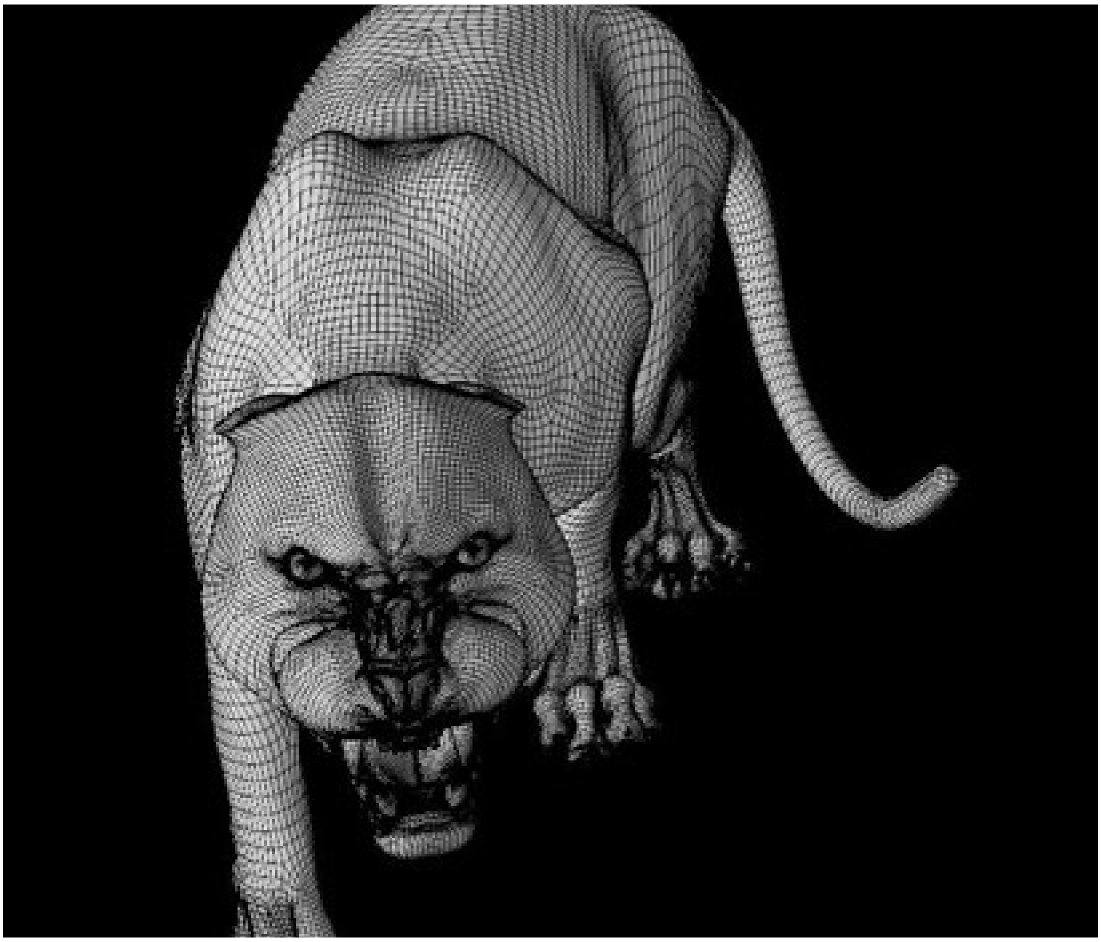


Fig 18. King Kong CGI (movie).

2.4.1.3 3D Printed prototypes

The 1980s saw a breakthrough in industrial fabrication as the so-called additive fabrication was proposed when traditionally subtractive fabrication was dominant in manufacturing. In additive manufacturing or 3D printing, 3D objects are produced by adding layers of material starting from nothing, instead of removing useless material from a full block (in the case of subtractive fabrication). This way of fabrication has been called 3D printing with reference to a similar technology used in ink-jet printers (Savini & Savini, 2015.).

Once the 3D designs for my study were modelled, I chose to 3D print the objects, which is an automated process in contrast to clay modelling. The result would also be stronger and sturdier as the clay prototypes were not fired and were suitable for visualization purposes only. There were numerous technical challenges that were to be dealt with. Beginning with the operation of the machine itself, and catering to the criteria of the printer to be able to successfully print my designs. Finding an optimum workflow between the modelling and slicing software also proved to be challenging, which works better with CAD based software.

For test purposes, a 3D file was sent to print. Originating from a non-CAD software (Blender) it read differently on the slicing software (Prusa), resulting in very large differences in scale. A cup that was designed 14cm high (in Blender) was microscopic in scale in the slicing software. Meaning, Blender’s measurements are correct within the context of the software but do not translate to the real world in the same way. A cube that is 2 meters in height within the software will look 2 meters high compared to a 5m cube next to it. But these objects are not of that scale if it were to be printed, instead it was more than a 1000 percent smaller than the intended size in the real world (according to the slicing software). This was another obstacle I had to overcome in this process.

After trying various methods and add-ons, the quickest workflow I chose to go with was through 3D scanning a handmade prototype and using that scale as a reference in the modelling stage. A quick 3D scan with a smartphone application produced decent results to give an accurate indication of scale. When imported into Blender it was clear how much bigger the scanned object was compared to the default “cube” in the software (which is 2m). I was able to create accurate sized models within the mesh-based 3D package without having to use CAD software. Making this a more visual and creative process than that of precision, which is one of the major factors that separate engineering from design. This method helped me in producing prototypes of different variations of my designs and replicating my designs accurately.

2.4.1.4 3D Printed Prototypes

Fig 19. 3D Printer with printed objects

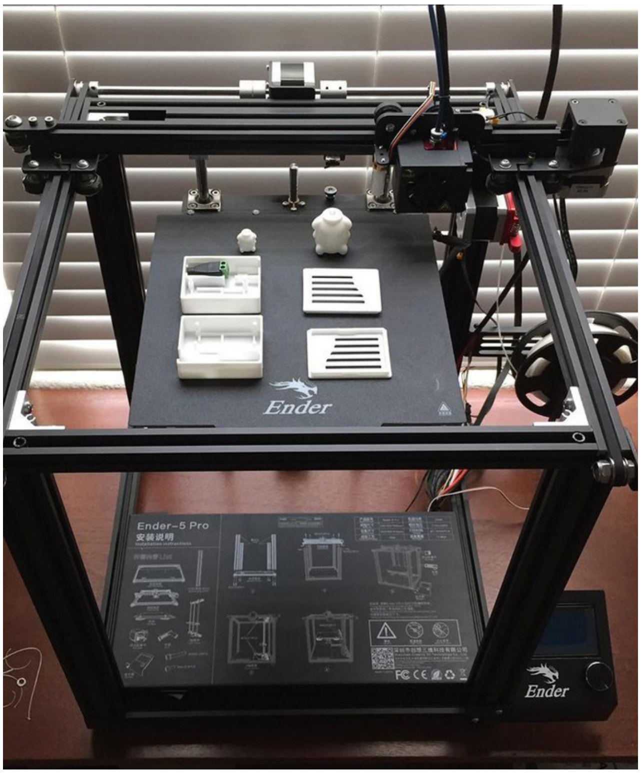
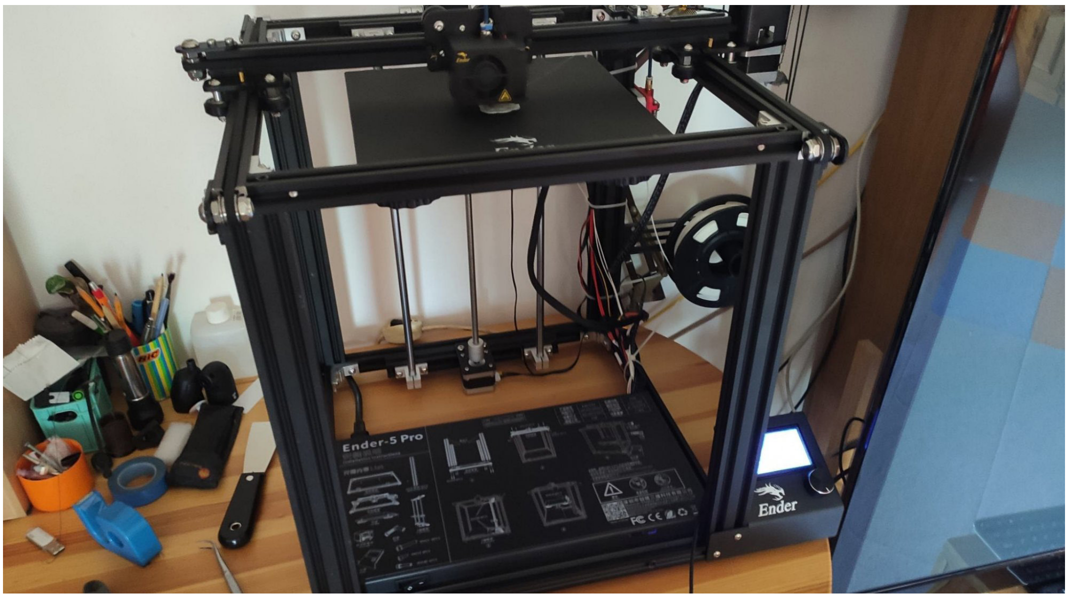


Fig 21. 3D Printed Pig

Fig 22. *3D printed objects (below).*

Fig 20. 3D Printer: Ender 5 Pro.



2.4.2 Reflection & Analysis

The project focus has been on conceptual development and prototyping rather than functionality and user testing. Being a practice-based project, the design process involved reflection in and on action (Schön, 1991) Reflection-in-action is reflection during the ‘doing’ stage of a process while reflection on action is reflecting back ‘in order to discover how one’s knowing-in-action may have contributed to an outcome The analytical process was heuristic, an approach to problem solving or self-discovery that employs a practical method which is not guaranteed to be optimal, perfect, or rational, but is nevertheless sufficient for reaching an immediate, short-term goal (Wikipedia, 2022). Heuristics refers to a process of internal search through which one discovers the nature and meaning of experience and develops methods and procedures for further investigation and analysis (Moustakas, 1990).

I developed the various iterations of the designs to fit my own body scale and was able to self-test the prototypes as they were developed. This also helped me develop the next version of the design. During the self-testing process, I set three guides based on which I evaluated the success for each design. (1) How well it conformed to the hand shape, (2) the haptic response, positive negative or neutral, (3) the aesthetics of the design, and (4) feasibility of the design (ease of fabrication). I also got feedback from your supervisors and friends to gain multiple perspectives and overcome my own biases. The future scope of the project could be user testing and feedback, which would be useful to develop further prototypes that worked for different body scales and shape.

Chapter Three: Design Experiments

3.1 Introduction to Design Work

In this section, I discuss the various prototypes that were created as a result of integrating hand-holding into a cup. A mix of physical and digital making methods (3D & clay modelling)were used to make various prototypes, both digital and physical. Some ideas started out as design concepts and ended up being stepping stones leading me to the next variation of the design.

The presentation of the prototypes are in chronological order. Beginning with the first design that was made out of physical materials which then progressed into the digital realm where many forms arose. Some of them were fabricated in physical form and evaluated on its affective feedback and affordance, while some remained in the digital state due to printing limitations, but were used to reflect upon and modify, resulting in newer designs.

3.2 The Clay Grip

The first experiment was to create a basic shape that conveys the intention of the design. It would help spark the design process. This study aims to draw out affect through the form of hand-holding into the design of everyday objects. To begin with, an obvious step was to see how the natural imprints of the hands' grip looks like, and to examine the sensation in our hands while holding hands, specifically interlocking fingers. A lump of air-drying clay was used to make the first prototype. The clay was kept moist by using a damp cloth to keep the clay from drying early and making it easier to work with. A cylindrical piece was cut from the clay by rolling it on the table and cutting both ends using a wire cable. It was a diameter of 6 cm and a length of about 12 cm. As it was meant to take the natural imprint of the hands grip, I pressed down on the clay stopping the either ends from displacing. Once the imprint was set on the clay, I began tweaking the design. This included smoothening out cracks in the clay, adding bits to areas that need more mass and refining the final shape of the design. After leaving it for a few hours to dry, upon holding it, the weight of the clay contributed positively to the haptic response that was received. The cool temperature of the clay did not replicate the warmth of human hands but still had a similar effect. The form fit well in my hands and was sturdy enough survive a little rough handling. The ring like features formed from pressing down on the clay mimics the sensation of fingers when gripped. It was also observed that during periods of hand-holding, the physical comfort comes from, or what stood out to me, was the stimulation of the inner sides of the fingers. It could be due to lesser nerve stimulation in those areas making them sensitive to touch.

However, clay still has its limitations and it needed to be handled with care. In other words, one couldn't squeeze the dried clay object too hard, or it may shatter, and the design lost. Finally, the design was created to only fit the right hand. A more flexible design that fitted both hands would be something to investigate in future designs.

Fig 23. Clay model with natural imprints

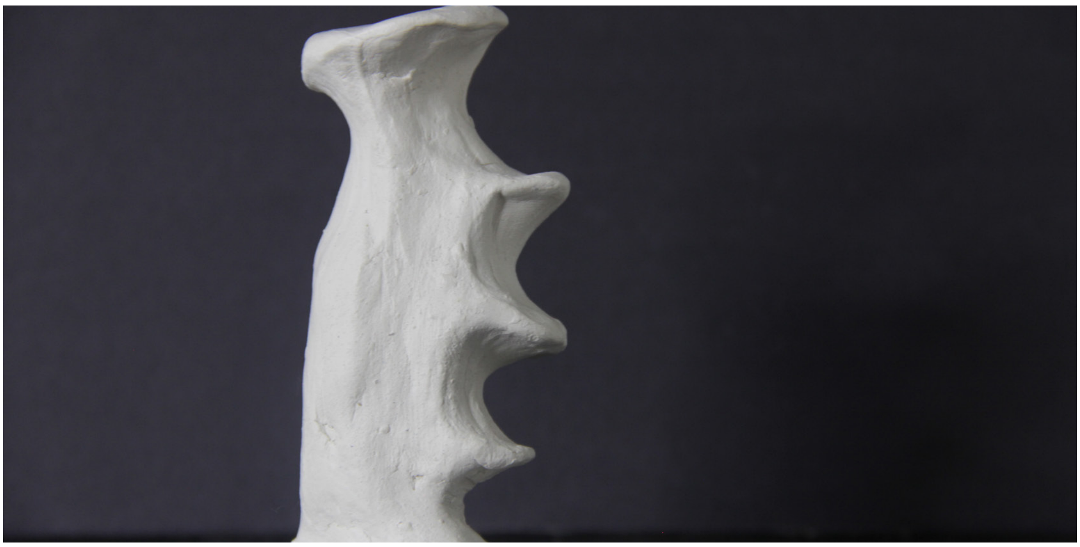


Fig 24. Clay model grip closeup

3.3 The First HapticCup

Progressing from the previous design, at this stage I wanted to integrate the design of the clay grip with a cup, an object that is commonly used by everyone. The idea behind this was to have an object that not only serves a utilitarian purpose but also presents an opportunity to playfully engage with this object.

For the first prototype I used a disposable drinking cup. Primarily for its large surface area that provided plenty of working room to develop the desired features. According to the natural finger placements on the plastic cup, the cup was marked. The design was that of an inverse hand. After adding clay strips to the cup, it was observed that the extrusions (inverse-fingers) on the cup required a specific height, and/or, depth to mimic hand-holding on the cup more accurately (*Fig 26*). This was tested by holding the cup while adding clay till the feeling was that of interlocking fingers. Clay was added to the part of the cup where it falls between our fingers, and the thickness had to be like that of real fingers. There were four strips placed with a height (from the surface of the cup) greater than that of the fingers (*Fig 28*). As expected, there was a comforting sensation between the fingers from the design, which brought the design closer to mimicking hand-holding (*Fig 25*).

My derivation from this is, because these regions of the fingers do not come in regular contact with objects and are sensitive, it feels comforting when it does get positive stimulus. The prototype instilled increased hedonic feelings and engagement compared to the original plastic cup. There were several obstacles that I had to overcome to make this prototype. Firstly, the clay is not exceptionally durable. Which invites only gentle handling of the object. I anticipated the clay drying in a day or two and needed to "save" the design for further modification. The cup not being durable, was unable to support the clay for more than a day and started to fall off the cup. This showed that it is not feasible to make multiple variations using this method. Therefore, I chose to transfer this model into the digital world, where I could take this design further and explore new possibilities.

Fig 25. Clay cup with less extrusions

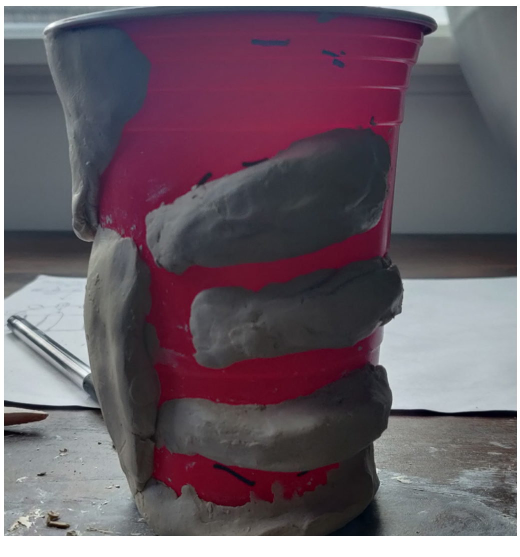


Fig 26. Inverse hand design on the cup.

Fig 27. Thicker fingers with clay strips

Fig 28. Fingers get support from the clay at the correct depth (Above & Middle Right).

Fig 29. Thumb placement on design

3.4 3D Scanned Geometry

At this stage my aim was to scan the previous prototype (HapticCup) and create a 3D mesh, based off the prototype. This would help me create further variations of the design. The scan was achieved through a smart-phone application (Pix4D) by taking multiple photos from all angles from which I was given a point cloud or pixel information in 3D space which is a cluster of points representing objects in 3D space.

Fig 30. Scanned clay cup front view. Pointcloud closeup, (right)

The challenges in this stage were that the scanned models cannot be directly modified in a non-destructive manner. Meaning, changes made to the original scan would not only disrupt the design, but also undoing changes would prove to be difficult. The scans high polygon count made it difficult to make changes to it. The best approach was seen to be to re-create the design using the scan as a guide to adhere to, which would also be flexible enough to incorporate new designs.

However, this step allowed me to get an accurate scale reference for the future designs as Blender's (3D program) scales do not match the scales when it comes to 3D printing. An object of 2m in Blender read as .002m in the 3D print- ing soft- ware when tested, which deals with real-world scale. So, this method would allow me to work without having to keep too many measurements in mind and give me creative freedom at the designing stage while keeping it a visual process as best possible.

Fig 31. 3D Scanned clay cup.

3.5 HapticCup - Sleeve Variation

This was the first replication of the 3D scanned object. The motivation behind this design was to make a sleeve for the cup from the scanned designs' features.
This was so that the user would have the option to put it on any plastic cup, similar to the one in the design. Since these are very regular designed cups, this sleeve can enhance the design and increase engagement.
This was made in Blender by creating a cylindrical shape (for the cup) and selecting the area I want the design in. After which the desired areas were extruded to resemble the inverse hand. The design would ultimately have to be printed on a soft material like silicone. This would make the object stretchable and give it a skin like texture. As a result, this was a more integrated design with hand-holding incorporated into it as the designed features and the cup unify at this stage as opposed to the previous one where the features and the cup were two separate elements.
The fabrication of this model would require the printing of molds and the use of silicone which was not the intention of my study, as the primary method of outputting my designs were by 3D printing. However, this object was a stepping stone to realizing the next designs. To be tested, the designs needed to be printed and evaluated. This design though not feasible to print, gave way to many other variations that could be printed.

In this process I realized that 3D scanning was not an efficient option for multiple objects, maybe a photogrammetry studio would produce accurate results that require minimal modification. But this would be unnecessary for this study. Therefore, I would need to design the other variations digitally to print them for testing. This was a one-off process where scanning was required to get the correct scale for the designs. It was found that this design would not be very convenient for everyday use as carrying the sleeve everywhere would not be practical.

Fig 32. 3D Scanned clay cup and sleeve design

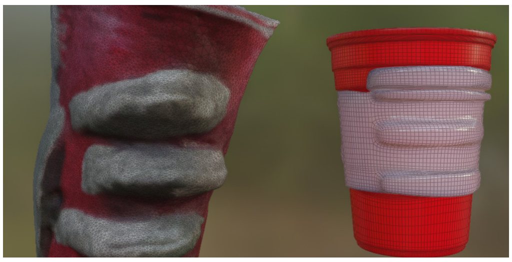


Fig 33. Haptic cup sleeve modelling stage.

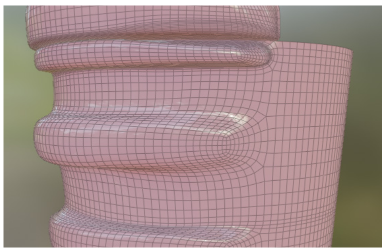
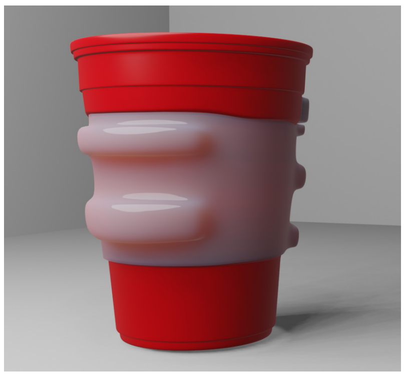


Fig 34. HapticCup sleeve render

Fig 35. HapticCup sleeve render close up.



3.6 HapticCup - Straight Rings

This design was created entirely digitally. Firstly to test what these “rings” feel like without following any natural curves of the hand. The simplification of the original design would allow the creation of new ones.
For this design I created a cylindrical object and matched the dimensions to that of the scanned cup in Blender. Which was around 80 times the size of the default cube (2m in Blender). The cup needed to have a width, or some thickness which would allow it to be a firm print. The base would also require thickness. The rings were created on the outer wall of the cup by extruding four rings from the cup. This would be a simplified version of the inverse hand design.

To print this object, there were some limitations. The rings could not be extruded (pulled out) beyond a certain point, keeping it from adding the thickness between the fingers which is vital in simulating the hand-holding sensation. By extruding further, there would be a need for supports in the printing process which would increase printing time to an estimated 24+ hours, which was not ideal for this experiment. Additionally, extruding the rings at an angle would also prove to be challenging as the material may not hold and deform while printing.

Therefore, a smaller version of the design was printed first. At 80% scale, the design printed in around 3 hours and served the purpose of testing for affordance. It was found that the object at a lower scale fitted my hand comfortably while the rings provided support to the fingers giving it a more secure grip. However, I was aiming for something that resembled the inverse hand design better.
At 100% scale, this design was a better fit for larger hands and it was noted that the security of the grip was somewhat lost in the full-scale model. In terms of affect, it subtly resembled the holding of hands but I felt at this stage there was more room to experiment and not give in to my own biases. Increased engagement with this object was relatively low compared to the first clay grip.
This could have been due to the weight of the former object whereas the PLA print, though heavy enough did not convey the same sensation. Hence, confirming the requirement for thicker rings on the cup.

Fig 36. Straight-ring cups printed at 100% and 80% scale respectively.

Fig 37. Straight-Ring Cup Renders.

Fig 38. Straight-ring cups 3D Prints.

3.7 HapticCup - Curved Rings

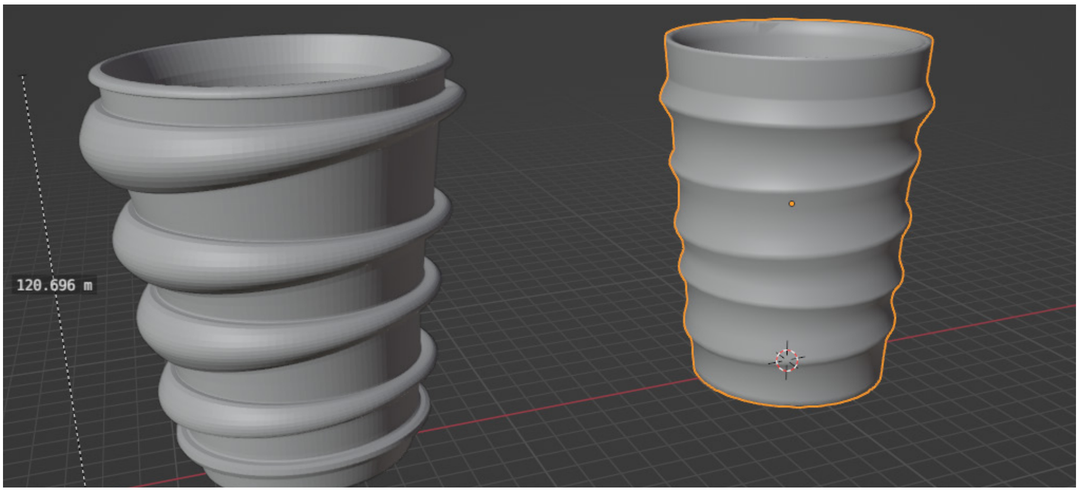
In this variation I wanted to make the previous design better fit the hand. This was meant to fit the curve of the palm. By rotating the top of the cup slightly, keeping in mind the constraints for 3D printing. An interesting result was achieved, the cup looked like the first clay grip design. I did not want to stray too much from the previous design as the printing time on it was already established (approximately 4 hours). A greater curve would have needed supports while 3D printing and would take an unnecessary amount of time. To hold, it felt like a more natural fit, this was expected since the design closely resembles the clay grip which is based off natural imprints. Higher levels of engagement was observed with this design with a secure grip and an interesting touch response from it. I felt that this variation was a turning point in the design stage, where it connected me to the initial design with clay and put me on a clearer design path.

Fig 39. Curved rings on cup prints.

3.8 HapticCup - Hybrid

This variation was a result of combining the previous designs. This object had to have thicker rings to simulate the thickness of fingers. A design that caters to both hands. I liked the look of the straight rings on the cup and therefore chose to keep that as the base mesh on which I build this design. I took the straight ringed cup and modified the rings. I wanted them thicker on one end and gradually becoming thinner, this way it can be held with the left and right hand. It will also produce a different sensation when held “incorrectly” (i.e fingers placed on the thinner side of the rings) and allows the user to adjust their grip to what suits them. The modelling process was similar to the previous designs. Only difference is that the thickness was applied non uniformly on this design. The later stages made this mesh high in polygon count and could not be edited after a certain point. This design took around 8 hours to print and felt sturdy to hold once printed. The thickness on one side simulated the holding of hands to a good extent, however, I felt that this could be enhanced further.

Fig 40. Hybrid rings on cup modelling process



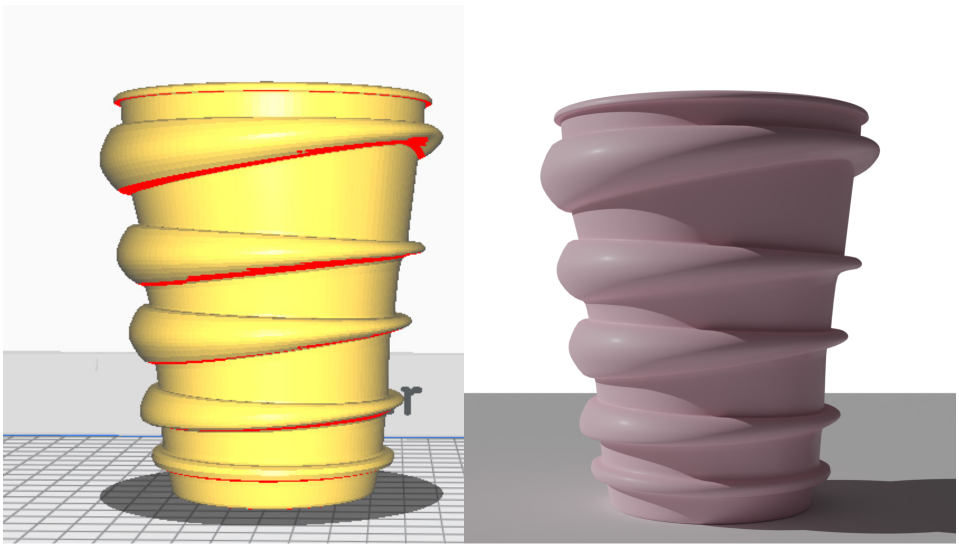


Fig 41. (Above) Hybrid rings on cup (test renders)

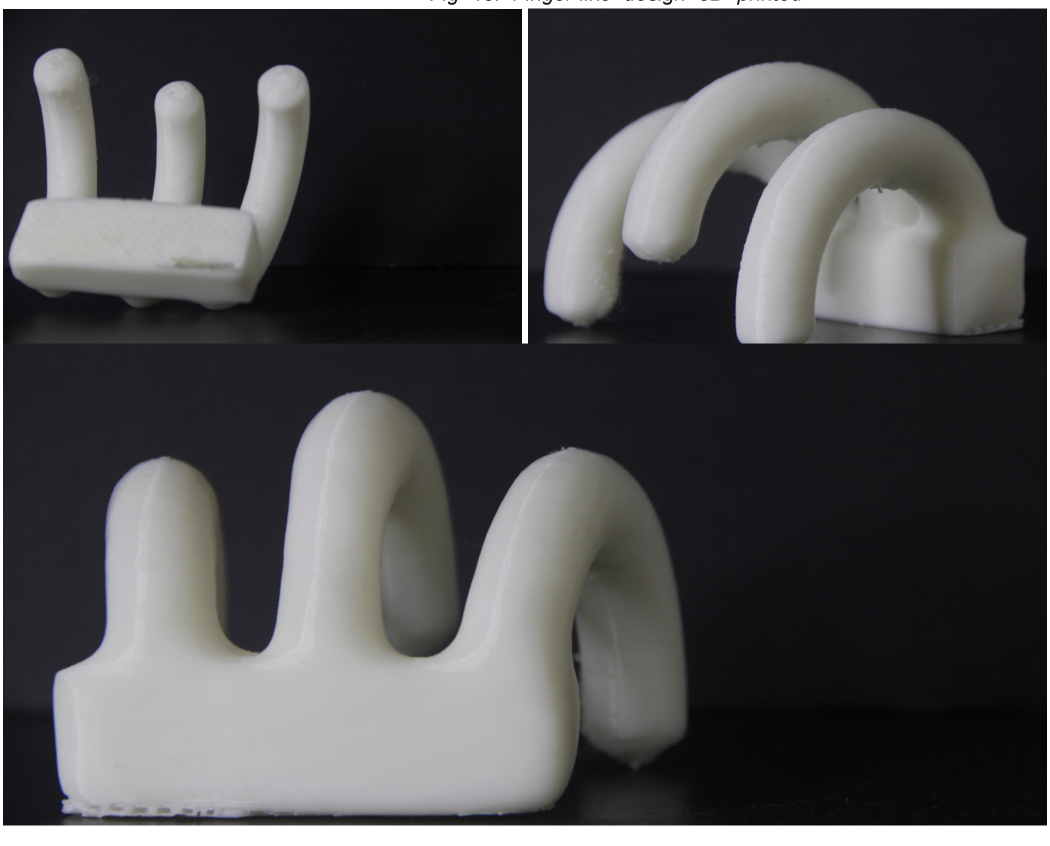
Fig 42. Hybrid rings on cup prints

3.9 Finger-like Protrusions

In order to enhance the features of the design I decided to refer back to the clay grip along with the knowledge gained from the previous designs. The thought behind this was the object wraps around your fingers. Here, in order to cut print times short, only the handle (where the design feature is implemented) was modelled and printed.

The design process for this object started from an elongated cube. This is the part that attaches to the cup. Three finger-like protrusions were made. The spacing between the fingers were done visually, using the cup model as a reference for scale. The “fingers” had to be long enough to be able to touch the back of the palm as is often felt when holding hands. The end of the fingers had to be level with the base of the object to minimize supports while printing. This took approximately 7 hours to print. It was observed that a higher polygon count resulted in a more smoother looking model. During the testing phase, it was noticed that the design was too narrow and the fingers were too thick, which was too tight to get a good grip on. It was also noticed that this design has potential for ergonomic use and could also be used to take the load off shopping bags. Therefore, the design replicated hand-holding quite well, as my fingers interlocked with the object, but was too crowded. In the context of the cup, this would make it a very complicated and even frustrating design to hold and interact with on a daily basis. Since the goal of simulating hand-holding is somewhat achieved in this design, in the next design iteration I explored variations based off this design to be able to integrate better with the cup and more suited to being held easily.

Fig 43. Finger-like design 3D printed



3.9.1 Finger-like Protrusions V2

The aim of this variation was to extend the earlier design. Corrective measures were taken to make the hand fit better in a more spacious layout, and the design to seamlessly integrate with the cup. The inspiration was to incorporate a hand, or a shape that closely resembles one, as the handle of the cup.

This was made using a slightly different technique. The initial 3D models were constructed by hard-surface 3D modelling, i.e. building the model by making cuts and extruding parts of a geometry to achieve the desired form. However, since I am aiming for a more organic structure, I decided to use the sculpting tools withing Blender to better allow me to mimic the anatomy of the palm. I used the smooth brush tool to soften out any hard edges and attempted to mimic the inside of the palm as well. The design was modified to accommodate larger hands, and the fingers on the design were made thinner.

The printing process took 4 hours, and preserved the shape of the original design. Upon testing it, I noticed that it very closely resembled the feeling of hand-holding which did lead to feelings of affection and intrinsic comfort, while it looked aesthetically pleasing. Increased engagement was also observed with this artifact.

However, I was limited to only printing this design in PLA which is a hard material and could potentially have a different outcome if printed with other materials. Printing this feature with the cup would take more than 12 hours and therefore decided to display and demonstrate the whole design digitally.

Fig 44. Finger-like design V2 printed

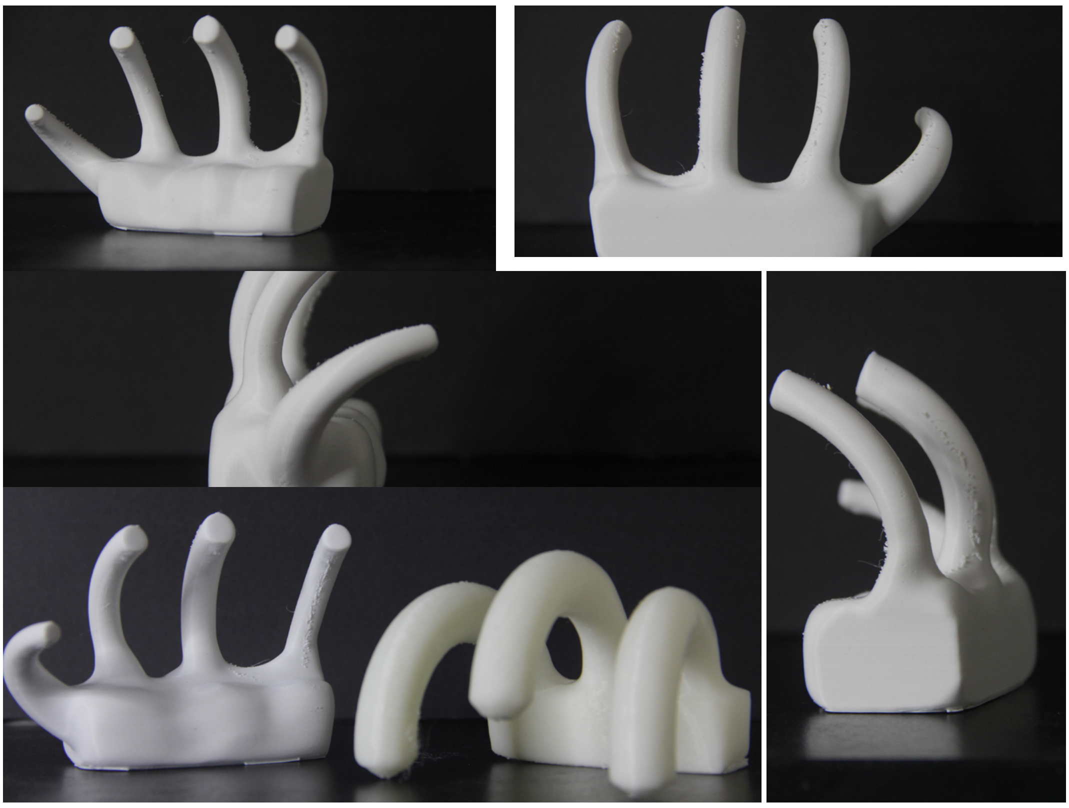
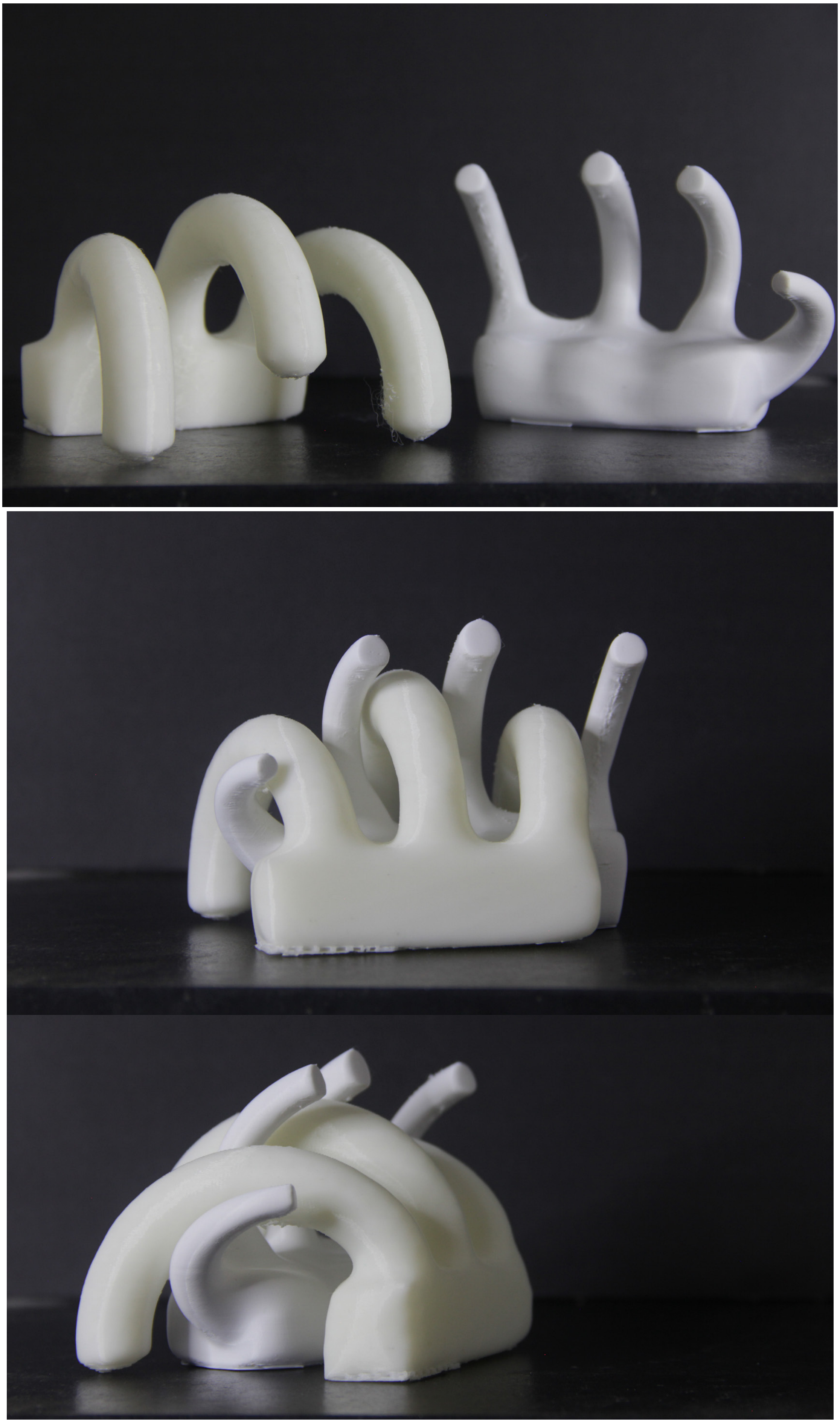


Fig 45. Finger-like design V1 and V2.



3.9.2 High Density Foam Experiments

Among other ideas and applications that incorporated hand-holding, was the “HapticArmChair”. This was similar design (an inverse hand) incorporated into the front of the arm of a chair acting as something to grip on to. Placed in a position where the hand meets that area of the armchair, makes it a subtle addition while still retaining its functionality but adding an engaging yet comforting feature to the design. This could have potential effects that can build up to something positive.

A brief experimentation with high density foam produced interesting results. The inverse hand was incorporated into a rectangular piece of foam. It closely resembled the first clay grip and was essentially the same design on a different material to test its tactility on a soft material.
Two variations were made, the first one similar to the clay grip, that was taller that broad, and has potential to be incorporated into objects with handles. The second, a broader version of the previous one, based on the concept of the “HapticArmChair”, made printed in soft material. A similar design that was 3D printed in PLA produced an artefact that was uncomfortable to hold and could not accommodate multiple body scales. This version in foam was a better fit for this purpose, due to its deformability and soft feel, it was observed that the “HapticArmChair” in foam, increased engagement and levels of comfort, therefore reducing stress.

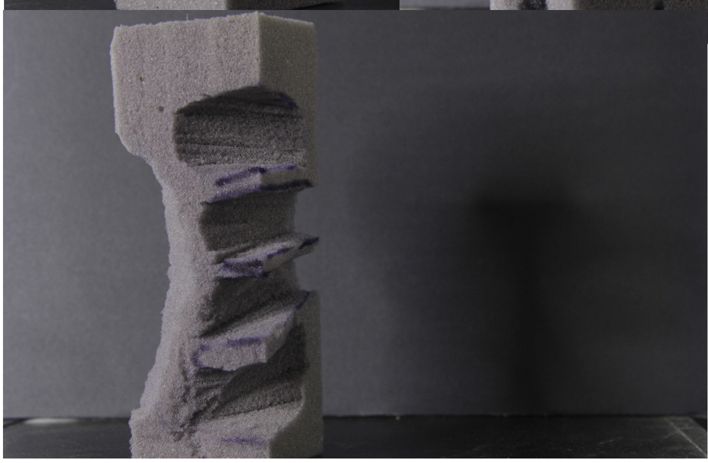
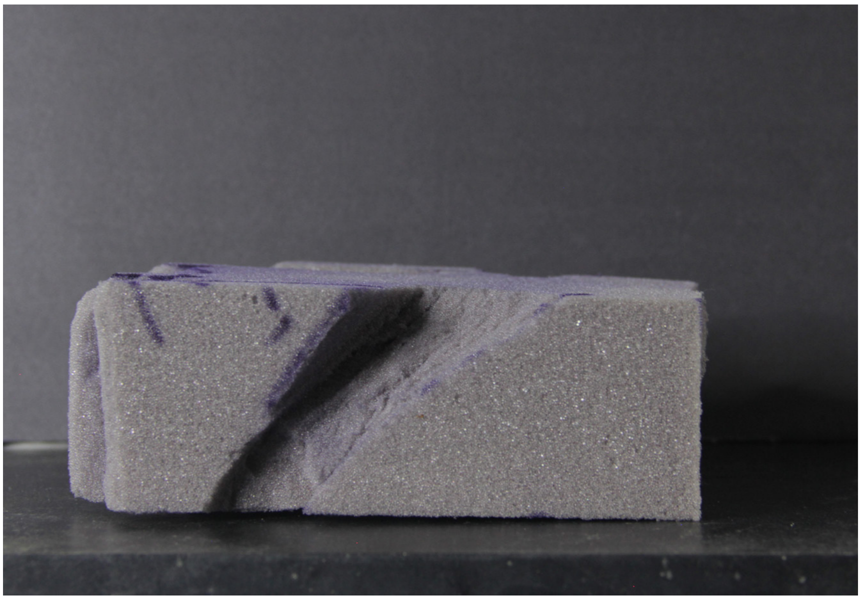
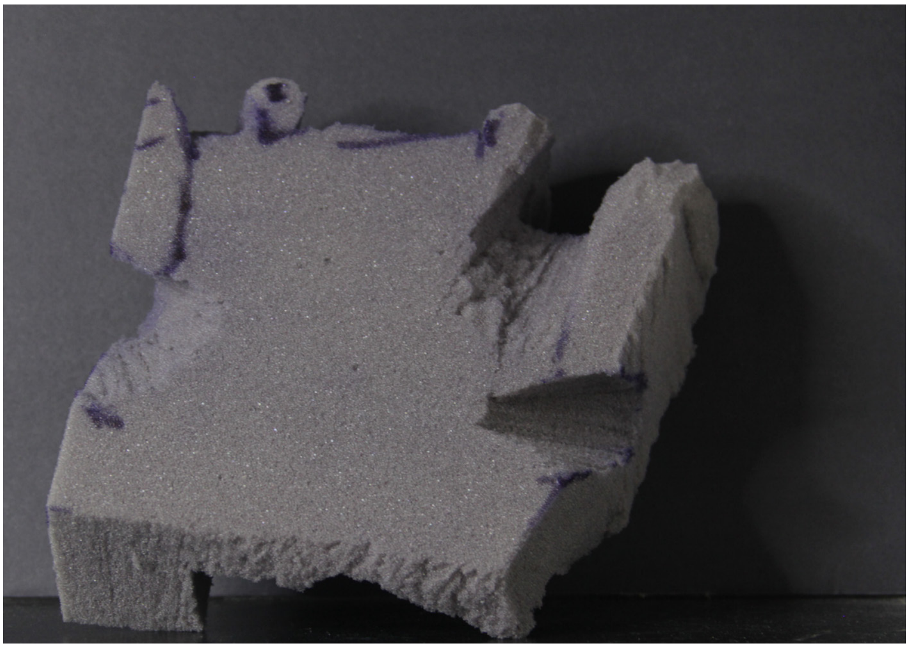


Fig 46. Foam experiment, similar to clay grip

Fig 47. Foam experiment, similar to clay grip. Front, top, and side views showing grooves for fingers.



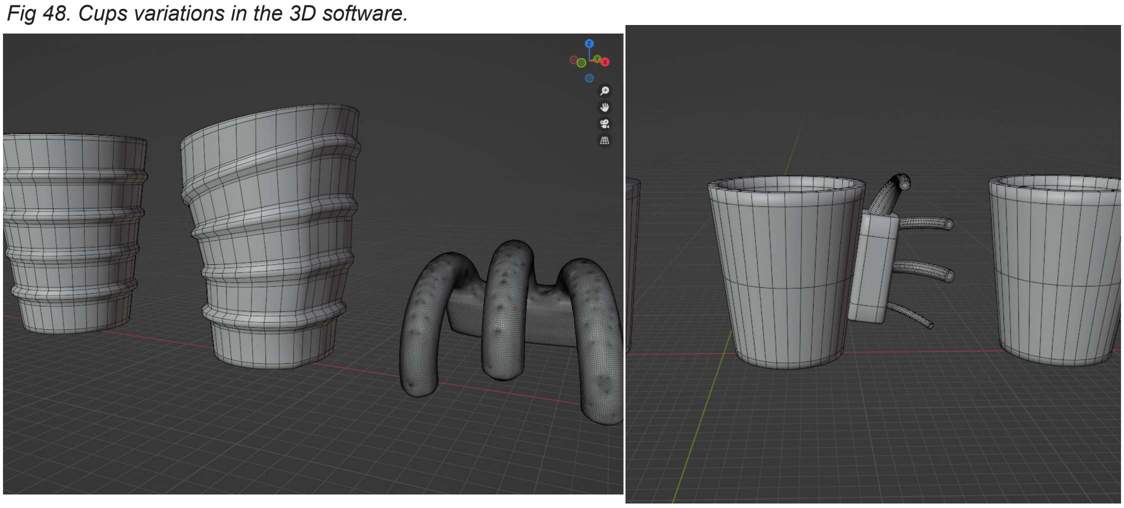


3.9.3 Digital Designs

“Digital Design Media constructs a lasting theoretical framework, which will make it easier to understand a great number of programs existing. Clear structure, numerous historical references, and hundreds of illustrations make this framework both accessible to the nontechnical professional and broadening for the experienced computer-aided designer”. (Mitchell & McCullough. 1991. pp. 421-422)

In this section, the designs that were created digitally and the various digital material properties that were assigned to them that can not be printed are displayed. Due to the high printing time proposed to print some designs, I chose to gauge their affective feedback visually. (*Fig 51, 53, and 55*).
The digital renders produced from Blender added an aesthetic aspect to the design by assigning properties like metallic, plastic, etc, to the objects. The shiny specular highlights on the metallic and plastic cups conveyed a smooth feeling cup. This had an awing effect on the viewer as it is a pleasant sight and the texture of these object was felt physically upon imagination and brought out a positive affective response.

Fig 48. Cups variations in the 3D software.



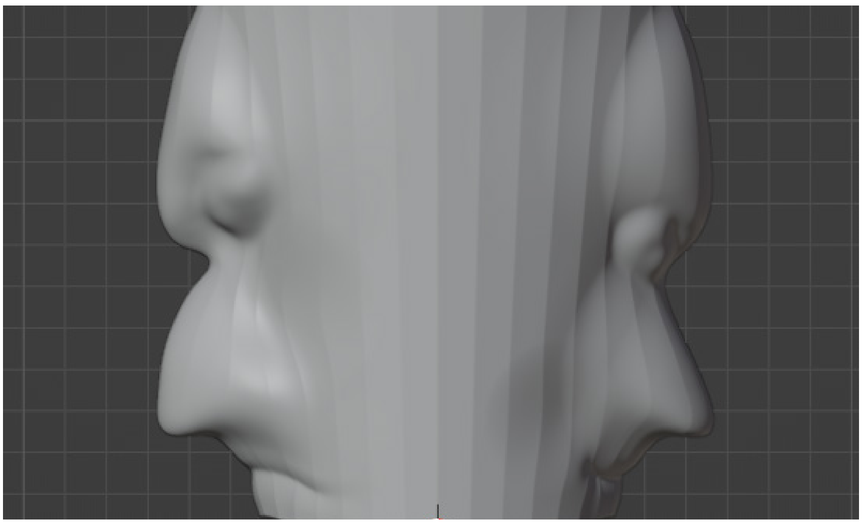


Fig 49. (Left) Experimental sculpt on cup to resemble human face.

3.9.3 Digital Designs

Fig 50. (Bottom) 3D renders of the straight and curved ring HapticCup. (Bottom Right) Modified HapticCup

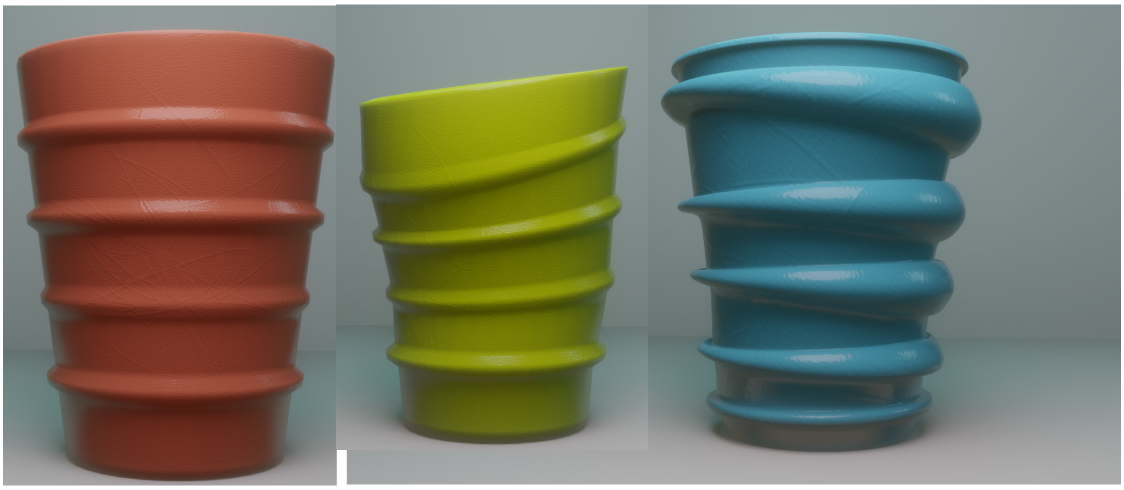


Fig 51. (Bottom) 3D renders of the Finger-like protrusions v2 in plastic & gold.

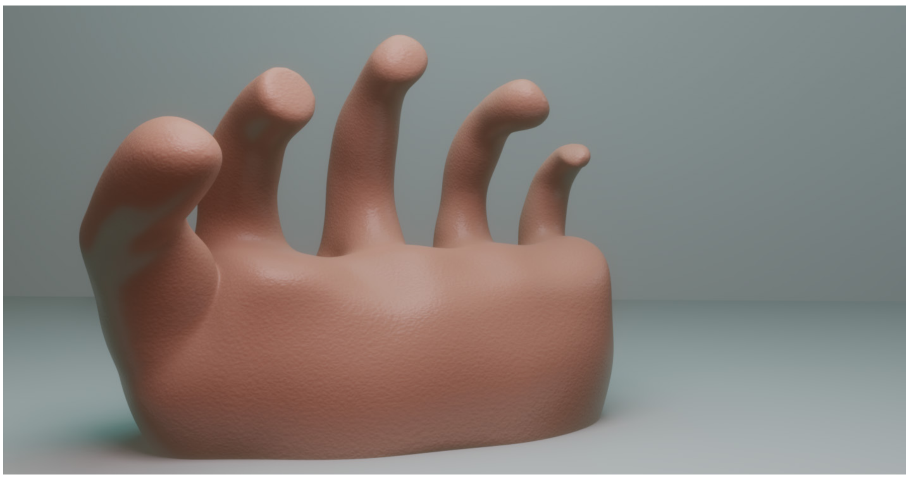
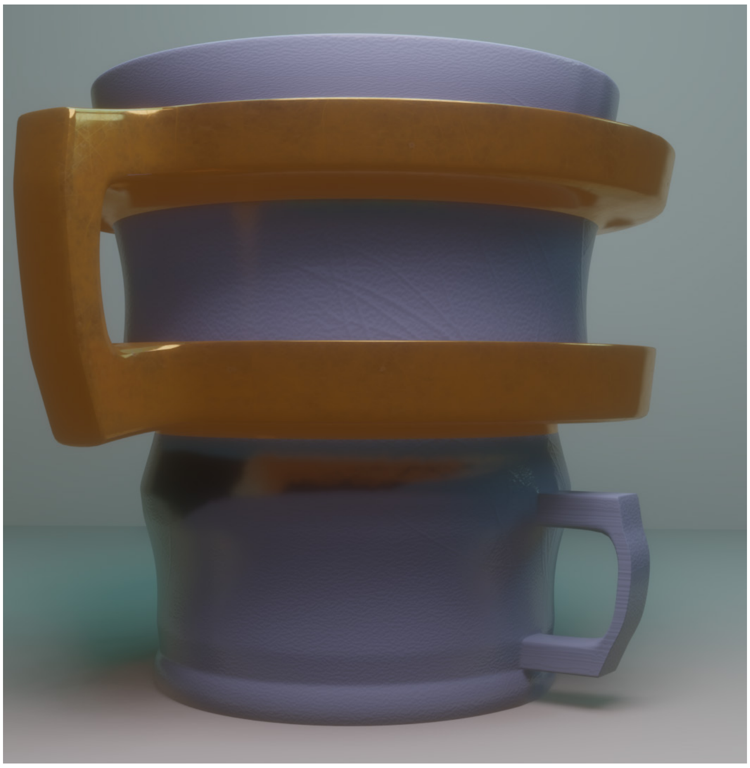


Fig 52. (Above) 3D render of experimental iteration of finger-like protrusions v2. Skin-like texture.

Fig 53. (Bottom) 3D render of experimental cup.



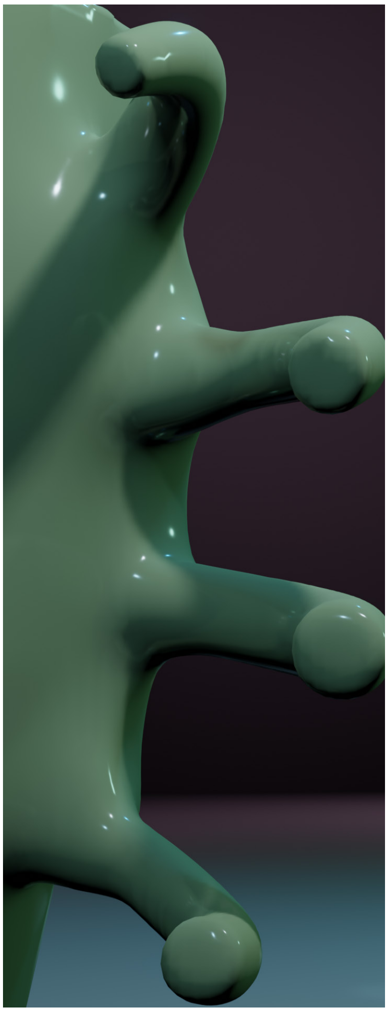


Fig 54. (Bottom) 3D render of Finger-like protrusion integrated with the cup

Fig 55. (Right) Close up of the integrated handle with the cup.

Fig 56. (Bottom) Full view of integrated haptic handle on cup.

3.9.4 Conclusion

In the current post-industrial world, we are more exposed to visual stimulus rather than haptic stimulation. The visual is recognized as "… the basic mode of contemporary culture, the general principal of structuring its forms." (Chayka and Averkievam 2016. p.1) This sensory orientation is being exacerbated by a further shift into the virtual world, leaving behind the material. The sense of touch and human emotion are closely entwined (Cell Press, 2014). In this study, the notion of touch and wellbeing is explored through the lens of 3D design. I embarked on this journey to create designs to bring out affective responses in people, underpinned by theories that hedonic features will increase engagement, contributing to the wellbeing of people.

We are living in a rapidly changing environment with new technologies and easy access to them. Modern-day computer graphics captivate our visual senses through cinema, advertisements, video games, etc. The importance of digital media has proven itself with the rise of digital technology, streaming platforms, and virtual reality. All these advancements seem to change the human experience to a visually dominated one, creating a big sensory gap by leaving behind tactile senses which are highly developed in human beings. Research on hedonomics has been around for centuries, but the focus of design has remained primarily on utility and ergonomics. It was found that hedonic features add a playful or engaging element to an experience that can benefit individuals by diverting their minds from busy and mundane schedules to simple focus-building activities for a period that regulates stress and therefore, contributes to their well-being. Touch, tactile or haptic feedback plays an important role in shaping our understanding of the environment and contributing to our well-being. Classen, (1999) states that we are not just creatures of the eye and require physical stimulation and may experience stress and frustration in its absence. This presents an opportunity for designers, that they must consider in their future work, and accommodate tactile stimulation in their designs, wherever applicable.

Holding hands is a common gesture that signifies assurance, trust, security, and comfort. It is prominent in primates as well. This points towards the fact that hand holding is a primal instinct in humans and primates alike. This can be perceived to be a form of haptic response one receives from holding hands which makes way for emotion, which manifested in the form of a feeling of security and comfort. Due to this reason, I chose to incorporate hand holding as the haptic 'emotion' I wanted to incorporate into my design. The aim of this research was to create designs that demonstrate higher and differing levels of tactile response which can help in alleviating stress through affective design features.

3.9.4 Conclusion

Initially, I had to select a base object for my experiments. This object had to meet certain criteria:, it needed to be a fairly common object, found everywhere, and be easy to use by individuals of all ages. This was because the intention was to have these designs in places where one might feel tense. Could be the workplace, schools, waiting areas, etc. Interacting with these objects could reduce stress levels.

The use of this object also needed to be considered as I did not want it to be too big, obvious, or inappropriate. Another aspect of selecting this object was the ability to modify and reproduce variations easily. To make these objects, first digitally, it needed to be a reasonably simple design to create, as I wanted to spend more time focusing on the haptic features and not the object itself. Lastly, outputting this object would need to be simple and not overly time-consuming, leaving room for accommodating the features which I anticipated would add to the printing time. In addition it was important to retain the functionality of the object. For example, the cup had to still be usable after the design was incorporated. As a design project it was critical that my design additions or extensions did not interfere with the utilitarian features of the cup. I selected a simple plastic cup/glass as a starting point, as this object fitted the criteria as it was an easily recognizable, domestic artifact that was operated by hand and also provides plenty of surface area to incorporate the designs into.

Methods of making the prototypes included various media across material, and the virtual platforms. I used a mixture of clay modelling and 3D design to create prototypes to refer to while printing. Due to the organic nature of the design, I decided to first make a clay prototype as this would give me a natural-looking shape. Other attempts at modeling without the reference resulted in designs that did not seem as natural and sometimes with incorrect dimensions. The designs were self-evaluated in a heuristic process. I had to be mindful of my own dimensional and aesthetic biases, but also recognized that this initial ‘self-testing’ process would be subjective to some extent.. Models were created modified and tested based on how close the design was to simulating the sensation of holding hands. The clay model was scanned using a smartphone application for a quick digital representation in 3D space. This was converted to a 3D mesh or geometry in the design software, Blender. 3D modeling after this step provided me with a basic mesh to begin working with.

3.9.4 Conclusion

The progression of the design was not linear and had two paths. The material pathway, was where I made the original design in clay and scanned it onto digital software, where the designs were modified and the first variation was created. The digital pathway was, where the scan was further developed into 3D models with more integrated features. This process had the advantage of allowing me to refer to older versions of a design if needed, in the digital process. This was a much more forgiving process than that of clay modeling or any physical making method, which does not allow much room for mistakes. The affective design feature based on hand holding was translated into the "rings" on the cup. A second concept was created from the rings, which were raised from the cup's surface to resemble fingers protruding from the cup. This feature would essentially be the cup's handle.

The first design straightforwardly demonstrated the rings in straight circles around the cup with even thickness The second design was a progression from the straight ringed cup, where the top of the cup with the straight rings was rotated approximately 30 degrees. This resulted in a design that better fitted the hand, as the curve on the cup lined up with the hand's natural grip. This gave the cup a more secure grip but did not feel like hand holding, which was the intended sensation.

It was noted that hedonic design features increase engagement and bring out a moderate affective response from the user. Digital technologies allow the concept of affect and well-being in objects to be explored in novel ways. The features, though not deemed to be playful, made the cup more engaging and interesting to interact with as it had a resemblance to holding hands. The rings on the cup were interlocked with the fingers giving not only a snug fit but also instilling a warm feeling while engaging with it. The varying factor in the cups was the thickness of the rings, which needed to be of a specific thickness to better create the desired sensation.
The opportunity to work with 3D design, physical models, and 3D printed models offered very valuable insights and lessons along the way. Having come from a digital background and no outputting experience I learnt that shifting from creating digitally to printing physically broadened my knowledge on the 3D printing workflow and has made me confident to pursue my experiments in future and 3D print using non-CAD designs and continue to refine this technique. I believe that there will be newer versions of the software that will allow more flexibility to print and design. The sensation that derived from the designed cups gave rise to a multitude of concepts that can be fabricated in future. They could be made of different materials with varying hardness and textures. To truly mimic hand-holding, printing in a material that heats up on touch could have interesting reactions from users. These designs can also be incorporated into other objects that we interact with often. This could be a pen, footrest, chair, couch, table features, mouse pads, etc.

Chapter 4: Future Implications and Discussion

4.1 Project Limitations

Due to the pandemic access to 3D printers was restricted at the university and initially I had to create my prototypes in another way. This pushed me to physically create prototypes. I experimented with clay, foam and paper mache, settling with clay for the future prototypes as it was easier to handle, and required minimal tools.

Having knowledge primarily in the digital part of the design process, the technical side of the 3D printing workflow proved challenging, and took a few attempts to understand. I learnt that the program (Blender) follows its own scale system and does not co-relate to real-world scale. As 3D printing softwares are used to dealing with CAD models, which are measurement specific, Blenders scale system produces inaccurate results on the printing software. This obstacle was overcome by persevering through the design stages and learning to design for 3D printing. The limitations of the 3D printer also affected the final result of the designs, the models were required to meet certain criteria to ensure a feasible printing time, for example, the rings on the cup could not be made deeper as it would need supports while printing which would add hours to the overall printing time. Many designs remained in its digital form due to such printing limitations.
Future research could investigate printing these designs with more technologically advance printers that may print them quicker. Due to the time constraint user testing could not be done and so, the designs were self-tested. This can be taken further in future by conducting user testing for various designs and materials, which in this study was also limited to PLA.

4.2 Project Outcomes

It was seen in this study that the addition of an affective hedonic feature in an object, i.e, hand-holding, translated into a design concept, incorporated in a cup resulted in mild feelings of comfort and relaxation, and brought out an affective response. Which aligns with Helander & Khalid's (2006) statement, mild positive affective stimulation causes the brain to release dopamine, which is the feel good hormone. Increased engagement and physical exploration of the object was observed in these objects as well.

A high level of tactile response was received from the clay grip where the clay material also played a part in contributing to the haptic feedback, as its cooler temperature brought out a curious reaction during self testing. Noting down the factors that caused this sensory stimulation helped me created the next designs retaining and enhancing the stimuli further. The protrusions that went between the fingers were the most important feature as they resembled the fingers in hand-holding. The next designs explored variations of the fingers' thickness.

To develop a sensory interface that is positively engaging and pleasurable I made various rings on the cup so that it retains most of its original form to not confuse the user, and pleasantly surprises them with an unusual design. It was observed that thicker rings on the cup simulated holding hands better than slimmer rings, like the straight ringed cup.

The movement of the designs from the material to the digital world gave me insight into the difference of the disciplines. Though it is not convenient, 3D printing as a designer is possible, with some challenges to overcome and with certain limitations which may change in the future with the development of newer and more capable 3D printers. The reliance on references is key to this workflow. While, 3D printers are still more compatible with CAD softwares, it was important to have a reference for scale in Blender due to the large differences in it between the two programs.

Digital technologies make it very easy today to move objects between the digital and physical worlds. This can have an impact on our emotions and wellbeing. Objects that we never imagined can come to reality causing a sort of dissonance. My designs achieved the desired aesthetic in the digital design phase which could not be done physically through just 3D printing. Various materials were tested on the designs including plastic, metal, rubber, and leather. These materials added character to the design and contributed to the playful aspect of the design.

Engaging with these artefacts was a playful experience and I enjoyed self testing the prototypes. I believe, though it is difficult gauging the designs contribution through self testing only, these designs did positively contribute to my general mood and emotion which was the point of the study. Since wellbeing is a larger aspect to analyze, it should be studied further to develop a deeper understanding of the role of such designs in human wellbeing.

4.3 Future Areas of Research

This project could be extended further by experimenting with different materials, a mix of 3D printed parts and soft materials, or printing in soft materials to mimic the human skin better in the design or the fabrication or incorporation of a material that is pleasant to touch. Other affective responses could be looked into as well, for example, a huggable bean bag. The comeback of analog interfaces could also be a source of inspiration to incorporate into objects with the goal to encourage positive engagement and betterment of ones wellbeing.

Testing hedonic features on other objects such would also be helpful in getting a better understanding of how these features affect people in other objects. User testing would also be helpful to gauge the affective response from a group of people of different genders, cultures and ages.

I plan to continue exploring affective designs and objects that can accommodate such features and ways they can contribute to peoples wellbeing. The knowledge of 3D printing will allow me to fabricate my ideas and make necessary changes to them as required. To achieve maximum comfort and high engagement in these designs, user testing would be crucial as multiple perspectives and suggestions on the design will be received. Designs to accommodate all body scales will be a challenge for future designers.

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