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GLASS CLAY

Throwing glass on the pottery wheel

Bachelor’s thesis

Smart and Sustainable Design

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Abstract
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This project desired to explore the potential of treating glass alike to clay, specifically through the technique of throwing glass on the pottery wheel, alongside an investigation into the sustainability aspects of glass clay. It represented an experimental set out, as similar concepts regarding the manipulation of glass were limited, extracted primarily from existing knowledge of the material and pertinent techniques.

Within this project, various trials were conducted to determine the optimal composition for the glass clay body, surrounding diverse experiments in colouring techniques and kiln programming, each relent distinctive outcomes. Among the tested formulations, the most promising combination was 50% wallpaper glue and 50% CMC, combined with 80% recycled glass and a requisite amount of water. This formulation resembled the tactile qualities of clay and facilitated comfort of manipulation on the pottery wheel. Coloration experiments involved the utilization of oxides, pigments, and coloured glass, with the latter proving to be the most sustainable and recyclable option.

Kiln programming played a pivotal role in determining the final characteristics of the pieces, with variations in temperature and duration influencing the degree of melting and shaping. Nonetheless, it was observed that the melting behaviour differed among colours, suggesting the need for further refinement and experimentation in this regard. The sustainability of glass clay was validated through the use of recycled glass as the base material, augmented by the incorporation of coloured glass, which posed no barrier to the recycling process. The addition of glue to the mixture proved inconsequential, as the combustion of the adhesive during the firing process resulted in a composition that was entirely glass.

In conclusion, this study demonstrated the feasibility of working with glass on the pottery wheel, even though with certain limitations in terms of achievable shapes. While significant progress had been made, further exploration was warranted, particularly in optimizing kiln programming for different colour compositions, where variations in melting points necessitated tailored approaches.

Keywords Glass, glass clay, pottery wheel, sustainability.
Pages 32 pages

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1 Introduction

1.1 Idea

One particular project has profoundly captured my attention — the exploration of throwing glass on the pottery wheel. The experience of engaging with this project has taken one's time in my thoughts, inspiring a continued obsession. I am eager to delve deeper into this technique, not purely for its technical elaborateness but also for the conceptual possibilities it presents.

During my first year of examination into various glass techniques, the research concept of glass-clay emerged and captivating my interest. Concurrently, I found myself drawn to the appealing art of pottery wheel work in ceramics. Captivated by both, I resolved to mix these passions during the consequent summer by embarking on an optional project that blended the two concepts.

The fusion proved fruitful, accede to creations that, while successful, were constrained in size, typically not exceeding 10 centimetres. Though, my current project aspires to transcend these limitations. My aspiration is: to craft larger pieces and explore a lineup of shapes through methodical experimentation and testing. This aim represents a journey towards pushing the boundaries, seeking to unlock new dimensions of creativity and expression. The initial project has motivated me to embark on further exploration and learning, concentrating on the deep concept of working with glass as if it were clay. This journey will not be restricted to the pottery wheel; rather, it extends to embrace other artistic techniques such as coil, slip cast, and even the innovative territory of 3D printing.

Beyond the artistic aspire, I am equally interest to determinate the sustainability of working with glass as clay. By building consequent to my existing knowledge from the previous project, I aspire to gain a overall understanding of the environmental implications and possibilities associated with this attractive medium. This aim reflects not only a commitment to artistic growth but also a dedication to contributing to the discourse on sustainable artistic practices.

The addition of new glass techniques by artisans and designers fosters innovation and the creation of unique, aesthetically pleasing glass products. This not only contributes to the evolution of artistic expression but also influences design across diverse industries. These techniques facilitate the diversification of glass applications, leading to the development of energy-efficient windows, lightweight structures, and wearable glass technology, through expanding the possibilities for integrating glass into various fields.

Sustainable glass techniques play a crucial role in minimizing the environmental impact of the glass industry. By reducing energy consumption during production, minimizing waste, and incorporating eco-friendly materials, these techniques contribute to a more environmentally friendly glass manufacturing process.

1.2 Key concepts

Glass: Glass is a material that is made by fusing sand with soda, ash and limestone.

Glass clay: It’s a term associated when you add another material, in this case glue, into the glass.

CMC: Product of the chemical industry and the result of processing wood pulp. The abbreviation CMC means carboxymethylcellulose.

Arabic gum: Natural gum originally consisting of the hardened sap of two species of the Acacia tree.

Body: In the context of glass, “body” it refers to the main mass or structure.

Pottery wheel: Is a device to shape clay into various forms. The wheel rotates on a horizontal axis, allowing the potter to shape the clay using their hands and different tools.

Kiln: This oven is purpose-built to achieve elevated temperatures, commonly exceeding 800°C.

Kiln program: A kiln program refers to the specific set of instructions or parameters used to control a kiln during the firing process. A kiln is used for firing or drying materials such as clay or glass. The kiln program dictates factors such as temperature, heating and cooling rates, and hold times at specific temperatures. It is crucial for achieving desired results in the final product, whether it's pottery, glass, or other materials.

1.3 Core questions

Core question: Is it possible to throw glass on the pottery wheel?

In the seeking of addressing the thought-out inquiry of creating a glass body with a clay-like texture, my research unfolds into a multifaceted exploration surrounding several pivotal questions and subjects crucial for the success of this project. The difficulty include investigating the usefulness of achieving a clay-like texture in glass, decisive the extensible for crafting larger pieces, understanding optimal methods for incorporating colour, evaluating the most effective kiln program, and contemplating measures to prevent the unwitting melting of the pieces. Each character of these inquiries holds significance in development the comprehensive understanding is required for the successful execution of this artistic struggle.

Sub-question 1: Could be possible to work with glass like we work with clay?

The extensive exploration of techniques for working with both clay and glass presents a various challenge that may require the implementation of several distinct projects. To adequately address the question at hand, it is crucial to undertake a series of experiments surrounding various methodologies. Particularly, investigating the combination of glass into the pottery wheel process holds potential for presence novel approach in artistic expression. The success of this effort could serve as a pivotal foundation for further experimentation with alternative techniques such as coil construction, building, slip casting, or even exploring the possibilities offered by 3D printing. The interplay between clay and glass on the pottery wheel may not only redefine the boundaries of traditional craftsmanship but also open up new horizons for artistic innovation.

Sub-question 2: Is glass clay sustainable?

While it is challenging to provide a definitive answer to this question, given the expectation that the components are designed to stand a lifetime, my research will focus on tracing the origins of the materials and exploring potential recycling methods. Although I may not achieve perfection in addressing this issue, I am committed to understanding the sources of the materials and investigating viable recycling approaches.

1.4 Exploration of Glass Art Techniques and Frame of references

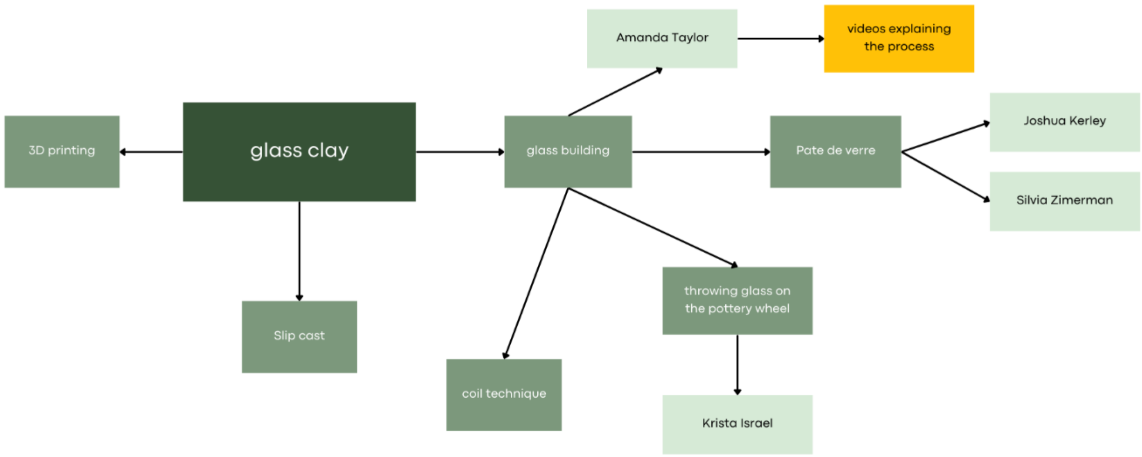


Figure 1 Glass clay map

Within the domain of glass art, my exploration has led me to discover artists employing diverse techniques such as pâte de verre, pottery wheel throwing, and hand moulding. Notably, glass artists Amanda Taylor, Joshua Kerley, Silvia Zimerman, and Kirsta Israel showcase distinctive approaches in their creative endeavours (Figure 1).

Amanda Taylor, through instructional videos, elucidates her meticulous process of moulding glass and crafting intricate figures using silicone moulds. Joshua Kerley and Silvia Zimerman, on the other hand, specialize in the pâte de verre technique, employing moulds to carefully shape their pieces within the kiln.

An intriguing venture, "Lapi Boli," led by Kirsta Israel, stands out for its innovative experimentation with glass throwing on the pottery wheel. This project, to my knowledge, represents a unique and singular exploration in the domain of throwing glass on the pottery wheel, providing a captivating perspective within the broader landscape of glass artistry.

2 Artist references

2.1 Amanda Taylor

Amanda Taylor, a distinguished kiln formed glass artist, instructor, and designer. With a passion for imparting the transformative potential of kiln formed glass, Taylor's multifaceted approach encompasses in-studio instruction, community outreach, video tutorials, and eBooks, catering to learners of all ages.

At the heart of Taylor's artistic journey lies an unyielding fascination with glass clay, which she masterfully manipulates to explore the vast expressive spectrum of glass. Her creations, bathed in the play of colour, texture, and light, serve as vessels for the reinterpretation of nature's timeless beauty (Figure 2, Taylor n.d.).

Figure 2 Vessel trilogy in fused glass by Amanda Taylor.

2.2 Joshua Kerley

Joshua Kerley is a distinguished artist, designer, and educator renowned for his expertise in kiln-glass. Graduating from the Royal College of Art's MA Ceramics & Glass program in 2019, after completing his BA in Contemporary Crafts at Falmouth University in 2011.

Through innovative kiln-glass techniques, he creates objects that defy conventional glass characteristics, instead mirroring the properties of other materials (Figure 3). This approach challenges perceptions of glass technically, aesthetically, and materially. Kerley seamlessly navigates between art, design, and craft, crafting sculptural and interior pieces that transcend boundaries and provoke contemplation about the material world (Kerley n.d.).

Figure 3 Shift; Pâte de verre footed bowl by Joshua Kerley.

2.3 Silvia Zimerman

Silvia Zimerman, born in Buenos Aires, Argentina in 1958, embarked on a remarkable journey from a career in accounting to becoming a celebrated glass artist. In 1976, she relocated to Israel where she would ultimately find her passion in the transformative medium of glass.

In her artistic practice, Zimerman seeks to capture the inherent beauty of glass, utilizing various techniques as vehicles for expressing different ideas and emotions. Her works, absorbed with a desire to provoke excitement and emotional resonance in her audience, are a testament to her fascination with the interplay of light and colour, as well as the implicit complexities of the glass medium (Figure 4, Zimerman n.d.).

Figure 4 Sculpture by Silvia Zimerman.

2.4 Kirsta Israel

Krista Israel emerges as a distinctive figure in the field of mixed media art, with a profound emphasis on the transformative potential of glass. Her artistic journey is akin to traversing through narratives, where each piece beckons the viewer into a world of visual storytelling.

One of the pivotal moments in Israel's artistic evolution occurred during a residency in China in September 2017, where she found herself immersed in the vibrant milieu of Jingdezhen, renowned as the cradle of porcelain craftsmanship. Inspired by this novel environment, Israel embarked on a daring exploration, blending the traditions of glassmaking with the venerable ceramic techniques of the region. The result was "Lapi Boli," a groundbreaking fusion where pâte de verre meets the potter's wheel—a testament to Israel's innovative spirit and her relentless quest for artistic innovation (Figure 5, Israel 2019).

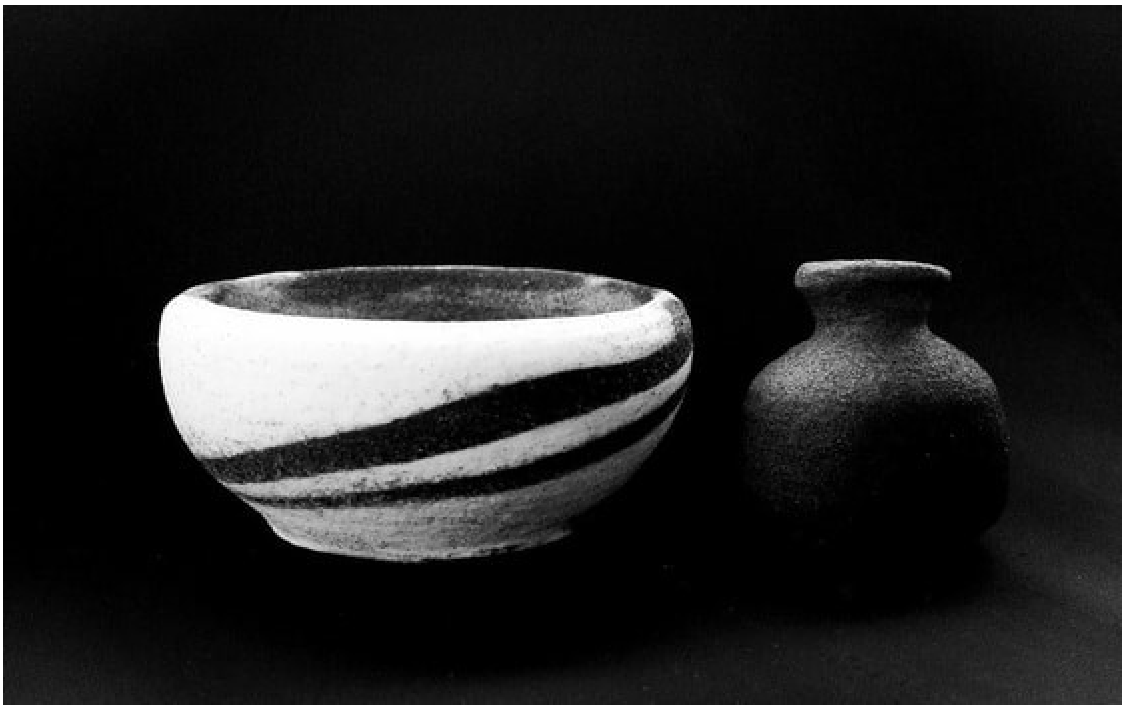


Figure 5 Pâte de verre thrown on the potter wheel by Krista Israel.

3 The sustainability of glass clay

3.1 The sourcing

The glass powder used in this project is the ones provided from Foamit company to the university. Foamit Company is a trailblazer in sustainable glass recycling, specializing in the transformation of float glass into innovative, environmentally friendly solutions. The company's approach involves meticulous collection and sorting processes, distinguishing between various quality classes of float glass to ensure high standards of recycling (Foamit n.d.).

3.2 Energy consumption

Creating pottery involves using both a pottery wheel and a kiln, each contributing to overall energy consumption. The pottery wheel, typically electric, draws power from a motor, the energy usage directly correlating with the motor's horsepower. Longer sessions or frequent use increase energy consumption. For accurate estimates, consider voltage and amperage specifications.

Glass kilns operating at temperatures up to 800 degrees serve distinct purposes, commonly employed for glass slumping or fusing. These lower temperatures require less time and energy, contributing to a potentially smaller environmental footprint. Glass kilns are often associated with lower emissions and may leverage recycled materials.

In contrast, pottery kiln programs reaching up to 1200 degrees are designed for complete clay firing. This process demands higher temperatures for vitrification, strengthening the clay into durable ceramic forms. Pottery kiln firings necessitate longer durations and higher energy consumption, posing sustainability challenges. Adopting energy-efficient kilns and sustainable clay sources can help mitigate environmental impacts associated with higher-temperature pottery firings (Frenzel 2020).

Unlike the warmth experienced while working with techniques as glassblowing or fusing, glass clay stands on unique cold hands working glass with techniques such as coil or hand building.

3.3 Life cycle

The life cycle of a piece of glass made from recycled glass begins with the collection of used glass containers, discarded by consumers into recycling bins. At recycling facilities, the glass undergoes sorting based on colour and thorough cleaning to remove labels and contaminants. Crushed into small pieces known as cullet, the glass is then melted at high temperatures, refined to eliminate impurities, and shaped into new products (recycling today, 2019).

These newly manufactured glass products are distributed to consumers and serve their intended purposes. Throughout their consumer use, glass products may be reused, refilled, or eventually reach the end of their life cycle. At this point, the glass product is collected for recycling once again.

The recycling process involves collecting, sorting, cleaning, crushing, melting, and shaping the glass into new products. This closed circuit of recycling system can be repeated indefinitely, exhibiting the sustainable and circular point of glass recycling. This life cycle offers several benefits, among other things, energy savings, resource conservation, waste reduction, and a lower carbon footprint. Essentially, the journey of recycled glass represents an unbroken cycle of sustainability (FEVE n.d.).

Glass waste management plays a pivotal role in environmental sustainability due to the unique recyclability and versatility of glass. Unlike many other materials, glass can be recycled indefinitely without compromising its quality, making it an extraordinary performer in waste reduction efforts (AGC n.d.).

3.4 Product durability

Recycled glass exhibits commendable durability, and its performance is comparable to that of glass made from raw materials. The durability of recycled glass is attributed to the unique properties of glass as a material, as well as the meticulous processing it undergoes during recycling.

Recycled glass maintains its inherent strength and integrity through the recycling process. When collected and sorted, the glass is carefully cleaned to remove impurities and contaminants. The subsequent crushing and melting stages do not compromise the structural integrity of the glass. In fact, the recycling process often enhances the durability of recycled glass by eliminating any weaknesses or imperfections present in the original glass items.

The resulting cullet, or crushed glass, is used to manufacture new glass products. These products, ranging from bottles and containers to fiberglass and construction materials, inherit the durability characteristics of the recycled glass. The durability of recycled glass products makes them suitable for various applications, and they can endure the rigors of daily use, transportation, and storage.

One key factor contributing to the durability of recycled glass is the absence of degradation during the recycling process. Unlike certain materials that may lose quality through repeated recycling, glass can be recycled indefinitely without compromising its strength or performance. This perpetual recyclability contributes to the longevity and resilience of glass as a sustainable material (Glass packaging institute n.d.).

Moreover, the durability of recycled glass aligns with environmental and economic sustainability goals. Products made from recycled glass contribute to the reduction of waste, the conservation of raw materials, and the lowering of energy consumption compared to producing glass from primary resources.

In essence, the durability of recycled glass is a testament to its versatility and resilience throughout the recycling process. As a sustainable material, recycled glass not only provides strength and durability in its various applications but also contributes significantly to environmental conservation and circular economy principles (Saint Gobain n.d.).

3.5 Social impact

The ability to manipulate glass as if it were clay holds significant social implications. For artists, this technique represents a fresh freedom to explore original forms and designs, pushing the line of traditional glass art. The combination of these skills in art education programs diversifies the skill sets of students, contributing to a more inclusive and varied artistic community as is possible to see with Amanda Taylor (Taylor n.d.).

Furthermore, the interdisciplinary collaboration between artists from different disciplines may result in exciting projects that combine the facility of glass with other materials or art forms. The technique can also play a role in the revitalization of traditional crafts, bringing new life to ancient techniques and attracting contemporary interest (Israel n.d.).

4 Glass clay

4.1 Research

In the territory of glass-clay, limited information is available, but certain artists working with analogous mixtures have generously shared insights that proved invaluable for formulating my own blends. Their experiences have provided a foundation upon which I can build while crafting my unique mixtures (Taylor n.d.). Techniques such as moulding, employing the pottery wheel, employing the coiling technique, among others, have surfaced as promising avenues to explore. Additionally, methods like slip casting and 3D printing, though not commonly associated with glass clay, are of particular interest and warrant experimentation.

Given the dearth of information on glass clay composition, the first phase involves extensive research and experimentation to determine optimal mixtures for the body. Once the ideal recipe is established, attention turns to the incorporation of colour. This involves a comprehensive exploration of sustainable colorants that not only enhance the aesthetic appeal but also prove compatible with both the pottery wheel and kiln. Post-drying, a crucial stage entails subjecting the pieces to various kiln programs, ensuring fusion without compromising structural integrity. This process necessitates careful consideration to prevent excessive melting and potential distortion.

While numerous techniques could be employed for working with glass clay, the pottery wheel emerges as the primary focus for this project. Despite the attraction of alternative methods such as 3D printing and slip casting, their inclusion would require an extended timeframe or a dedicated project. Consequently, the pragmatic decision to concentrate efforts on the pottery wheel, deemed the most effective means of initial experimentation and evaluation within the scope of the project.

4.2 The body

Commencing from the foundation of my previous project on glass clay, I initiated the formulation of various recipes for the clay body. The fundamental ingredients included wallpaper glue and glass powder. To systematize the creation process, I designed a chart delineating different percentages and materials (Figure 6). Holding to specific guidelines, the procedure involved crushing all the materials to achieve a finer powder. The next step was to initially mix the dry components and subsequently introduce water. Once the amalgamation was complete, the resulting mixture was stored in a plastic bag, allowing it to rest overnight before practical use.

Figure 6 Test body mixtures.

	Glass 90%	Glass 80%
Wallpaper glue 100%	Exhibits exceptional qualities conducive to effective manipulation. The formulation proved to be highly favourable for work, offering an optimum consistency.	Demonstrates positive attributes suitable for practical use. A commendable choice for work, offering a good balance of consistency and malleability.
CMC 100%	Demonstrates positive attributes suitable for practical use. A commendable choice for work, offering a good balance of consistency and malleability.	Falls within an acceptable range but may require slight adjustments. Adequate for work, with room for improvement through minor modifications.
Arabic gum 100%	Presents difficulties due to excessive liquidity. Despite its potential, excessive liquidity renders it impractical for use in its current state.	Presents difficulties due to excessive liquidity. Despite its potential, excessive liquidity renders it impractical for use in its current state.
Wallpaper glue 50% CMC 50%	Stands out as the most optimal for effective artistic manipulation. The formulation excels in workability, offering an ideal consistency for artistic attempt.	Exhibits exceptional qualities conducive to effective manipulation. The formulation proved to be highly favourable for work, offering an optimum consistency.
CMC 50% Arabic gum 50%	Falls short of the desired consistency, being excessively soft. Lacks the necessary firmness for effective work, making it unsuitable in its present state.	Falls short of the desired consistency, being excessively soft. Lacks the necessary firmness for effective work, making it unsuitable in its present state.
Arabic gum 50% wallpaper glue 50%	Poses challenges due to excessive softness, hindering practical use. Not recommended for work in its current state, as its overly soft composition limits effective manipulation.	Presents difficulties due to excessive liquidity. Despite its potential, excessive liquidity renders it impractical for use in its current state.

4.3 Colour

Selecting between oxides, pigments, or coloured glass to change the aesthetics of glass involves considering sustainability factors. Metal oxides, like iron oxide or copper oxide, are commonly chosen for their resource efficiency and lower carbon footprint, being derived from natural minerals. Pigments offer an all-around colour range, allowing accurate control for consistent results and minimizing waste through careful administration. Coloured glass, whether in the form of pre-coloured glass cullet or frit, simplifies the coloration process during glass production, potentially reducing energy requirements.

When analyse sustainability, recyclability is crucial. Methods that do not restrict glass recyclability, such as oxides and controlled use of pigments, are often preferred. Energy efficiency is another consideration, with oxides and pre-coloured glass potentially offering advantages in requiring less energy for coloration. Toxicity is a concern, and while oxides are generally less toxic when used in controlled amounts, careful management of pigments is necessary. In the pursuit of sustainable practices within the area of ceramic art, the choice of colorants plays a crucial role in shaping environmental impact. This section of the thesis delves into the sustainability aspects of coloured glass compared to traditional pigments or oxides commonly used in ceramics.

Coloured glass come up as a sustainable alternative in glass outstanding to several key factors. Its leaning on recycled glass reinforces raw material efficiency, reducing the need for new resources and minimizing the environmental impact of extraction and processing. The manufacturing process of coloured glass have energy efficiency, requiring lower energy consumption compared to pigments or oxides. Lower melting temperatures contribute to overall energy conservation.

Moreover, coloured glass demonstrates reduced toxicity compared to traditional pigments or metal oxides used in ceramics, promoting both environmental and occupational safety. Its recyclability ensures a closed-loop system, minimizing the demand for new colorants and reducing the overall environmental impact.

In conclusion, coloured glass not only offers aesthetic appeal and unique visual effects but also aligns with sustainability principles such as resource efficiency, reduced toxicity, recyclability, and waste reduction.

4.4 Exploration of Glass Colouring Techniques

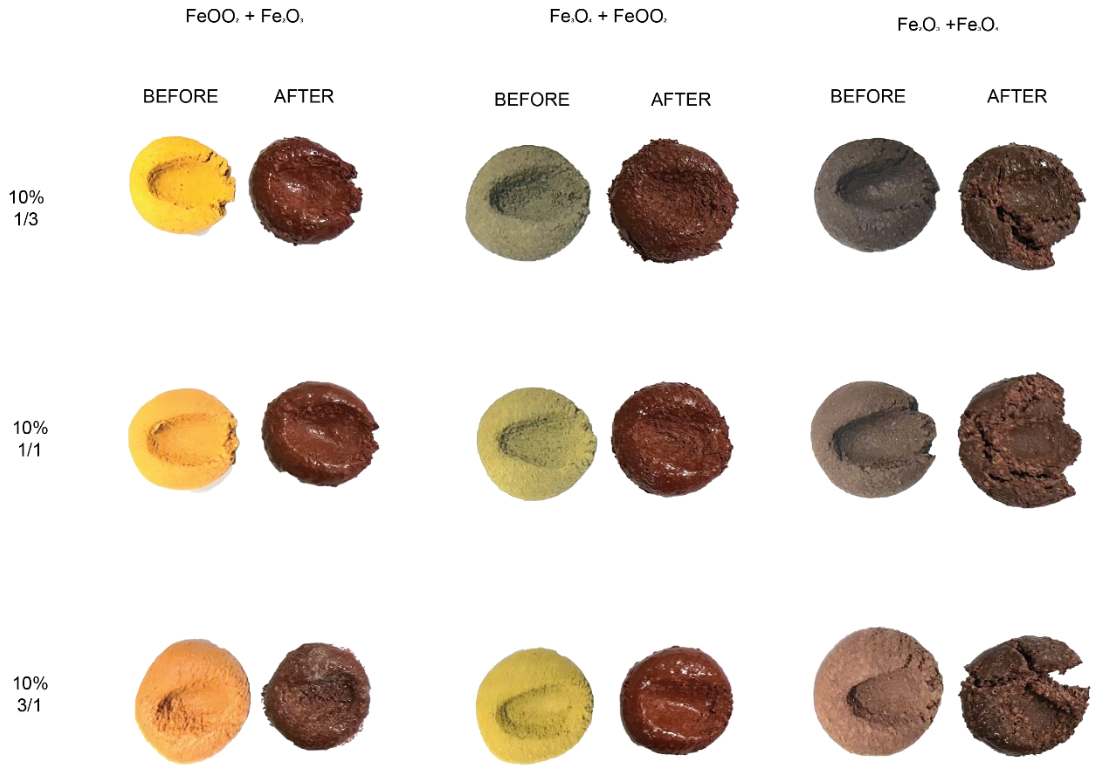
In the pursuit of colour experimentation for my project, I opted to explore three distinct methods, leveraging the availability of materials at hand. To systematically guide this exploration, I meticulously crafted a chart outlining the varying percentages of pigments, oxides, and coloured glass that will be introduced to the glass. This chart serves as a comprehensive reference, providing a clear overview of the inputs and guiding my subsequent steps in the creative process. Through this methodical approach, I aim to gain a nuanced understanding of each colouring technique, facilitating informed decision-making and ensuring a well-informed execution of my project.

For the experimentation phase of my thesis, I opted to explore the effects of three different colours—3%, 5%, and 10% concentrations—across various measurements in the kiln program. This initial step aimed to observe the visual and reactive transformations that these colours undergo during the kiln process, providing a foundation for further exploration.

Upon commencing the testing with oxides and observing their reactions in the kiln (Figure 7), as well as experimenting with oxide mixing (Figure 8), it became evident that the colours, initially vibrant and appealing before the kiln, underwent unexpected changes. Kiln program number 3, in particular, provide a consistent colour palette, altering the original shapes and, in some cases, leading to break.

Figure 7 Oxide test I.

Figure 8 Oxides test II.



Transitioning to pigment experimentation (Figure 9), I tested three different colours to assess their brightness and structure post-kiln. Despite the initial vibrancy, the glass lacked lustre and exhibited an unsatisfactory appearance. Subsequently, incorporating coloured glass into the same program (Figure 10) revealed that while the colours did not appear distinct initially, the post-kiln results surpassed expectations. Although the colours were not as bright, the glass retained its integrity, prompting me to delve deeper into this avenue.

Figure 9 Pigments test.

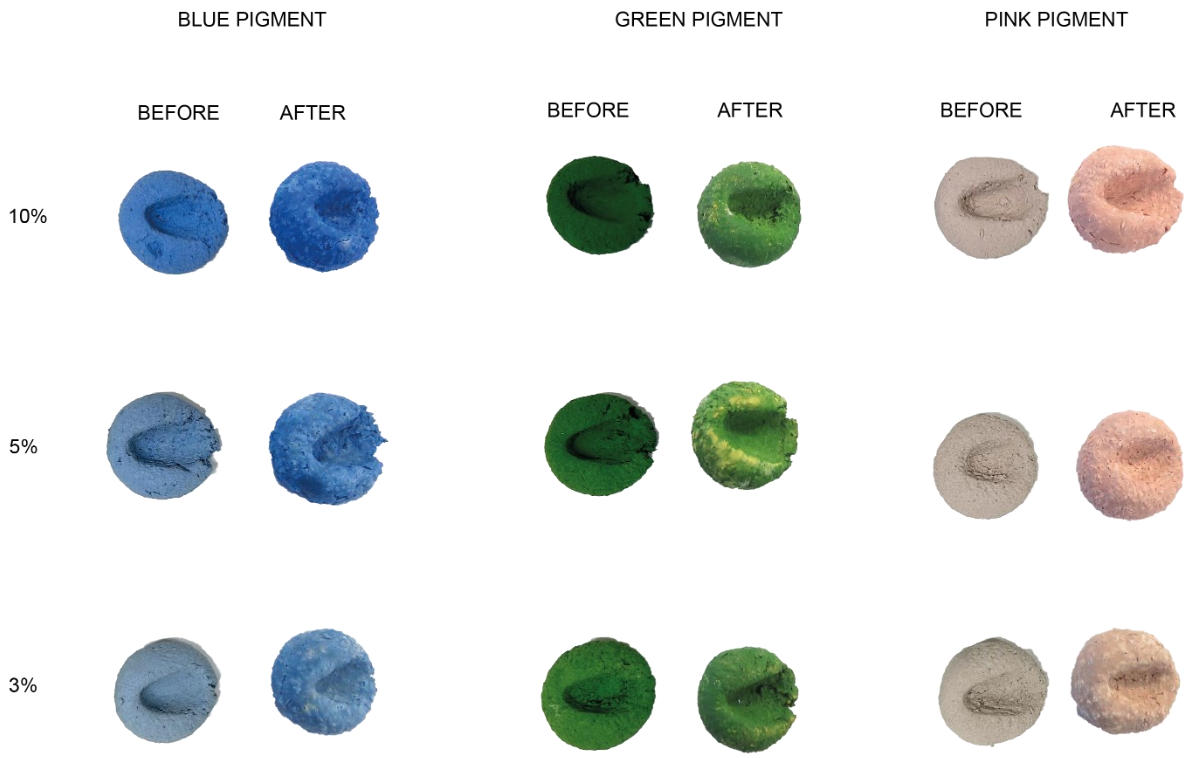
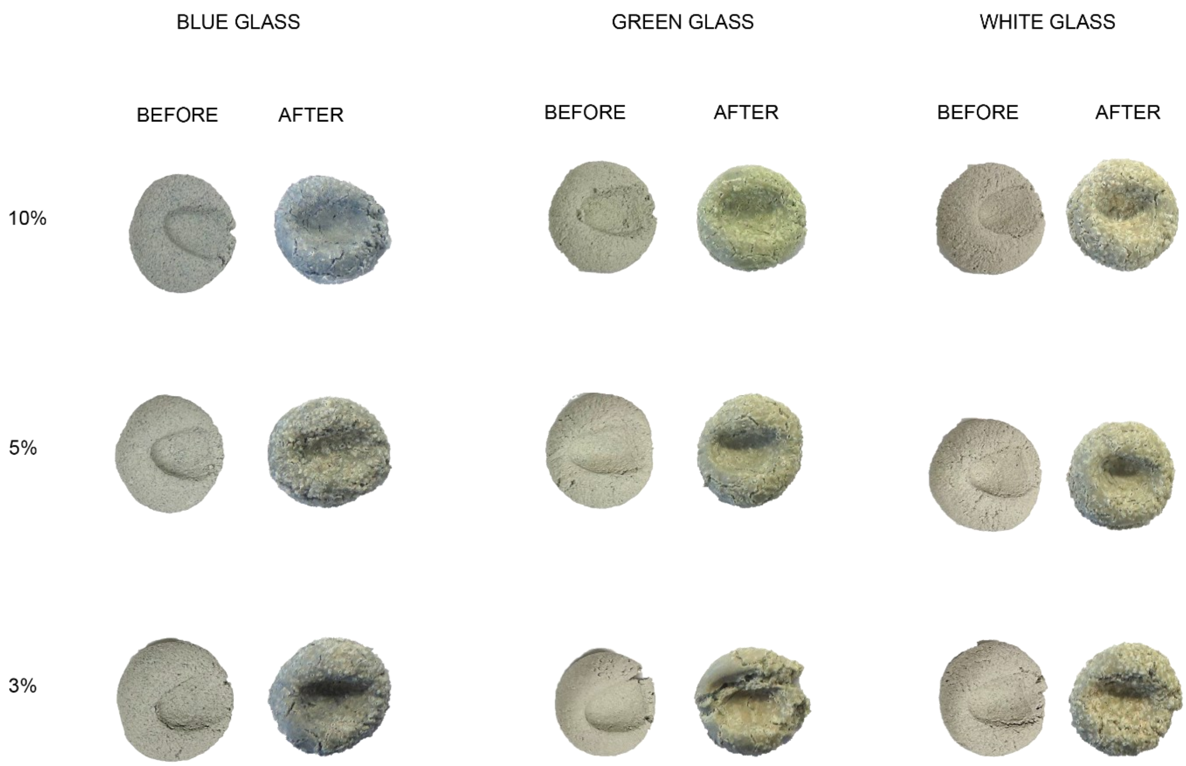


Figure 10 Coloured glass test.



Continuing the exploration of coloured glass, I selected the most readily available colours in the storage room—blue (Figure 11) and white (Figure 12). By introducing varying percentages (15%, 20%, and 25%) of coloured glass and employing kiln programs 3, 4, and 5 with temperature fluctuations, peak temperature, and temperature-holding durations, respectively, I sought to determine their impact.

Through comparative analysis, it became apparent that white glass exhibited a smoother melting process compared to its blue counterpart. This characteristic enhanced the final result by ensuring uniform melting of all glass components, a quality lacking in the blue variant. Interestingly, the white colour did not turn entirely white, but the resulting colour and dot effects were aesthetically pleasing and natural. Consequently, I have chosen to further develop my project with a focus on the white glass option.

Figure 11 Coloured blue glass test.

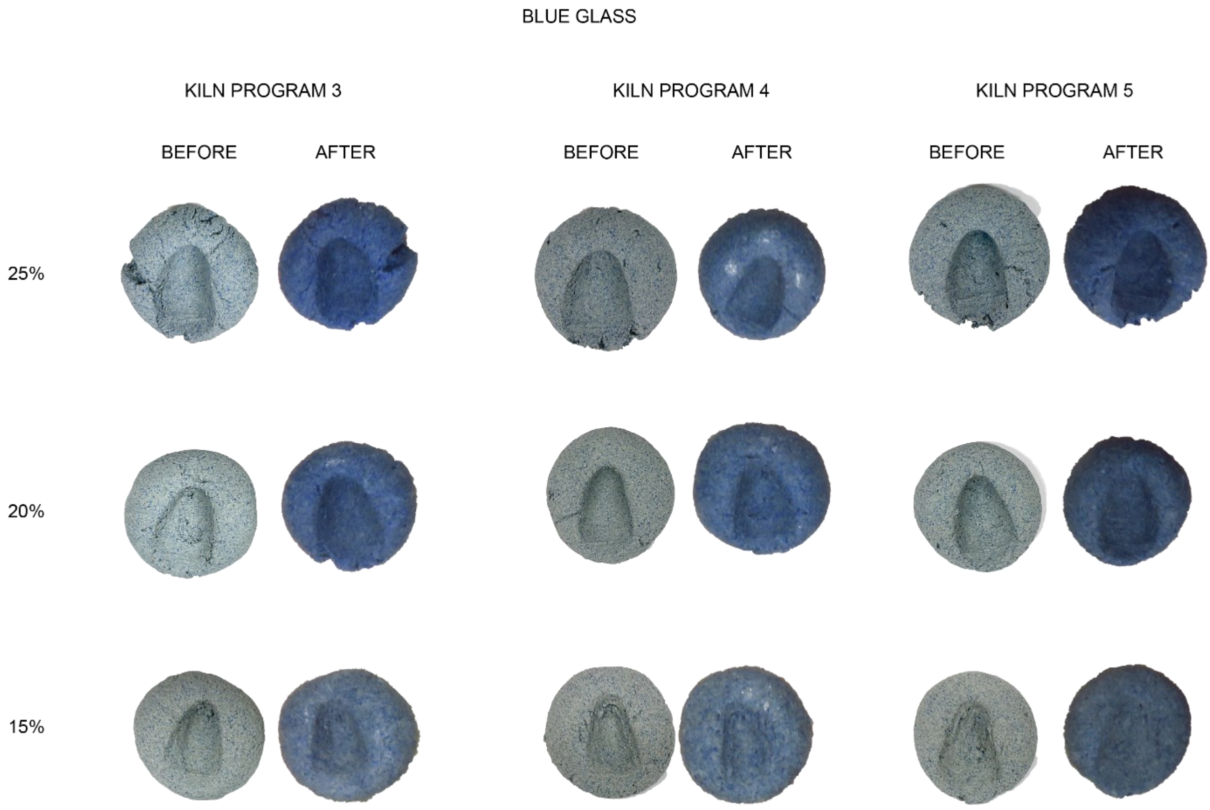
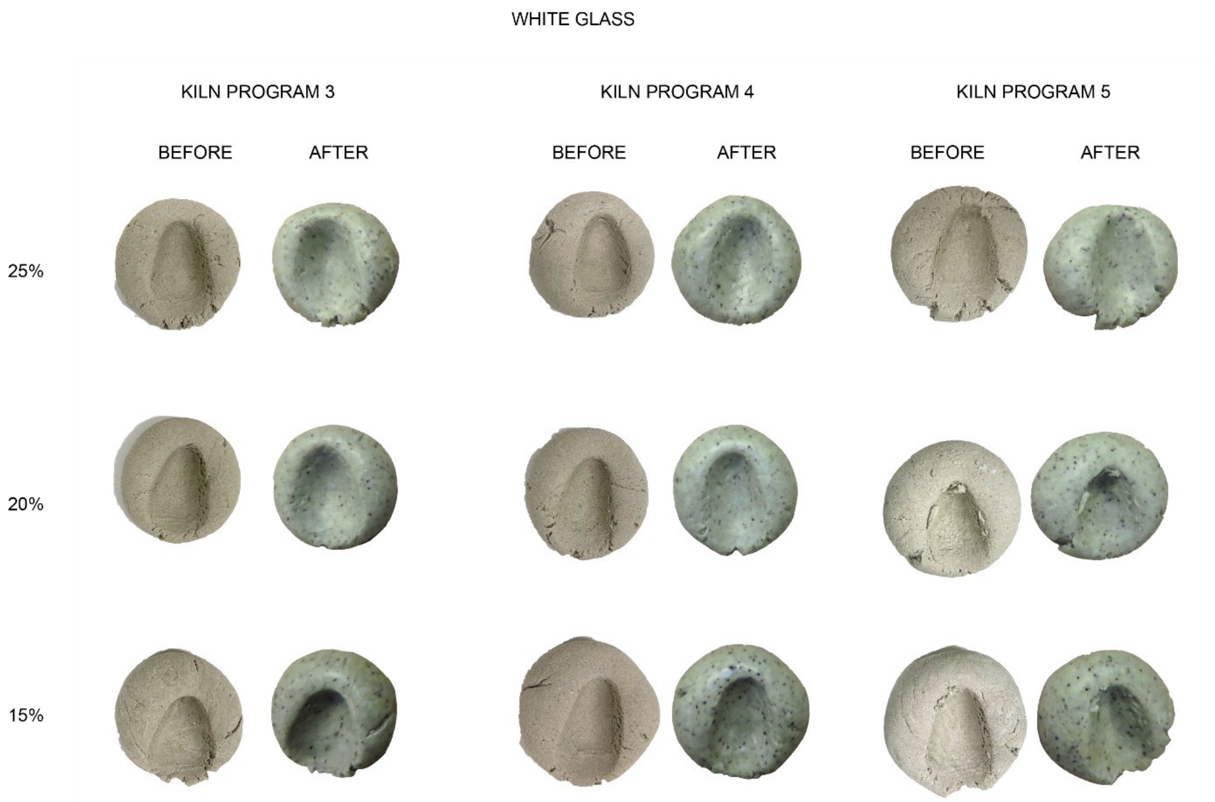


Figure 12 Coloured glass white test.



5 Kiln

5.1 Testing Coloured Glass Samples

In the examination of coloured test pieces, a meticulous strategy was employed to determinate the glass's response to varying kiln conditions. The objective was to discern the optimal parameters, whether a gradual process, an ideal temperature, or an elevation in temperature proved most effective. The kiln program employed for this purpose was carefully chosen to facilitate a comprehensive understanding.

Recognizing the potential for the pieces to melt, I made the decision to position them upside down on the kiln using Aluminium Oxide ($Al2O3$). This not only ensured that the pieces retained their shape during firing but also using this material addressed concerns regarding their safety for food use, as Aluminium Oxide is a food-safe material (NIH n.d.).

This method allowed for a systematic exploration of the glass's behaviour under different conditions, providing invaluable insights into the intricacies of its reactions. By utilizing the basic kiln program (Figure 13), the study aimed to uncover subtle details that make it complex and interesting in the glass's response, aiding in the formulation of informed decisions for future artistic aim and ensuring a more profound comprehension of the material's characteristics.

Kiln program 1

150 degrees per hour to 530 degrees and hold 10 minutes.

200 degrees per hour to 820 degrees and hold 15 minutes.

Skip to 530 degrees and hold for an hour.

30 degrees per hour to 430 degrees and don’t hold.

70 degrees per hour to 320 degrees and don’t hold.

110 degrees per hour to 25 degrees.

Figure 13 Fired piece kiln program 1.

Kiln program 2

100 degrees per hour to 530 degrees and hold 10 minutes.

150 degrees per hour to 820 degrees and hold 15 minutes.

Skip to 530 degrees and hold for an hour.

30 degrees per hour to 430 degrees and don’t hold.

70 degrees per hour to 320 degrees and don’t hold.

110 degrees per hour to 25 degrees.

Figure 14 Fired piece kiln program 2.

5.1.1 Evaluation of the test pieces.

The outcomes of the test pieces diverged from the anticipated results, as they did not achieve the desired level of fusion (Figure 14). Remarkably, the observed reactions in the kiln were not as expected, pressuring a observative revision of the firing conditions. It is my belief that a more gradual ascent in temperature, coupled with an rising in the peak temperature, may be essential to facilitate a thorough and successful melting of the glass components.

This realization accentuates the dynamic nature of the glass-firing process, highlighting the need for refined adjustments to achieve the proper outcomes. As I continue to mature the technique, these findings will serve as a valuable guide, contributing to a more informed and precise approach in future pursuit.

Kiln program 3:

75 degrees per hour to 530 degrees and hold 30 minutes.

100 degrees per hour to 830 degrees and hold 20 minutes.

Skip to 530 degrees and hold for an hour.

30 degrees per hour to 430 degrees and don’t hold.

70 degrees per hour to 320 degrees and don’t hold.

110 degrees per hour to 25 degrees.

Figure 15 Fired piece kiln program 3.

5.1.2 Refinement of Kiln Program

Following the successful implementation of a kiln program test (Figure 15), a discernible enhancement in the lustre and sleekness of the glass was observed. Noteworthy was the preservation of the glass's shape, achieved without undue melting. Cheer up by these encouraging outcomes, a decision was made to delicately refine the ascent process with the aim of exploring the potential for achieving an even more radiant and polished appearance, all while maintaining the structural integrity of the piece. This led to the adoption of the modified approach (Figure 16 and Figure 17).

Kiln program 4:

50 degrees per hour to 530 degrees and hold 35 minutes.

75 degrees per hour to 840 degrees and hold 20 minutes.

Skip to 530 degrees and hold for an hour.

30 degrees per hour to 430 degrees and don’t hold.

70 degrees per hour to 320 degrees and don’t hold.

110 degrees per hour to 25 degrees.

Figure 16 Fired piece kiln program 4.

Kiln program 5:

50 degrees per hour to 530 degrees and hold 35 minutes.

75 degrees per hour to 850 degrees and hold 20 minutes.

Skip to 530 degrees and hold for an hour.

30 degrees per hour to 430 degrees and don’t hold.

70 degrees per hour to 320 degrees and don’t hold.

110 degrees per hour to 25 degrees.

Figure 17 Fired piece kiln program 5.

6 Throwing on the wheel

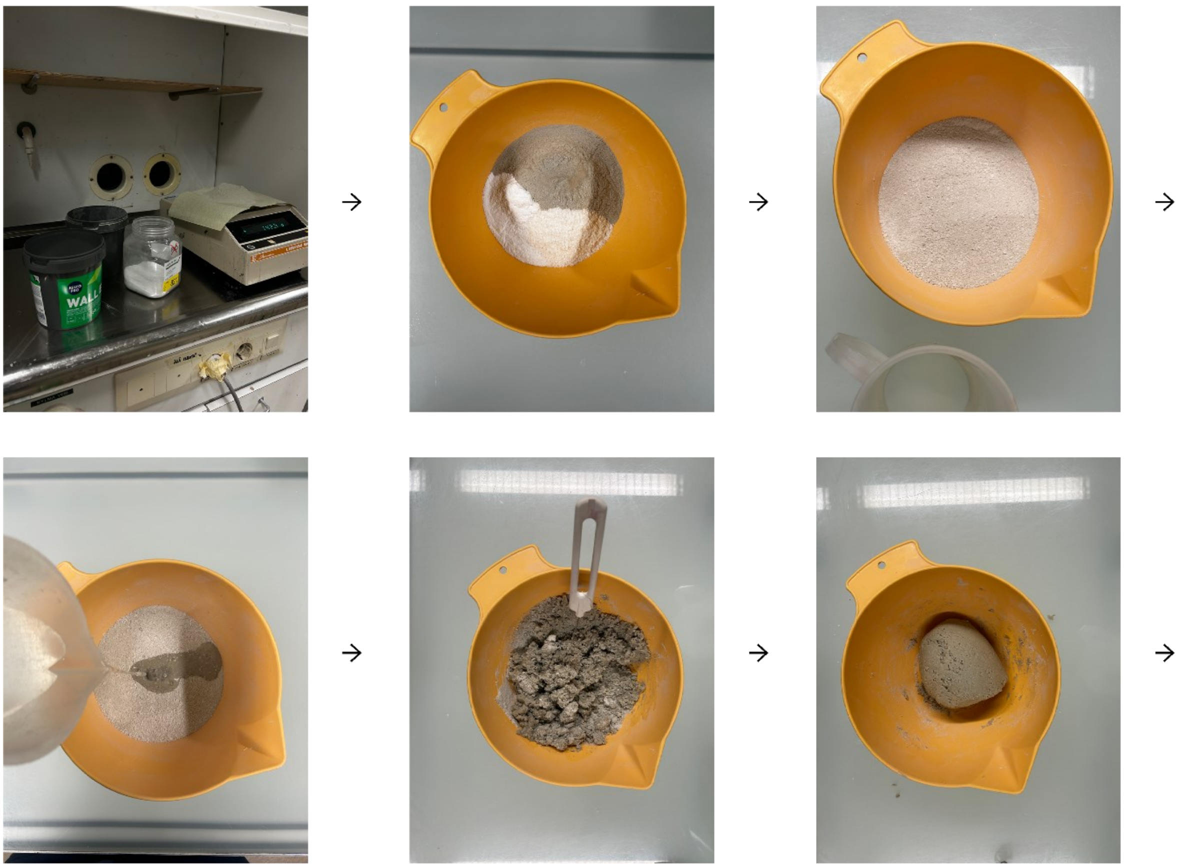
6.1 Glass- body creation

For the throwing tests, I conducted two substantial batches of glass bodies, each weighing 500g. These bodies were crafted from a composition of 425g recycled glass, 37.5g CMC, and 37.5g wallpaper glue, with the addition of water to achieve homogeneity (Figure 18).

In exploring the coloration aspects of throwing, I further conducted tests using five batches, each weighing 300g. Extensive experimentation led to the determination that this specific quantity yielded optimal results on the wheel with my formulated recipe. Each batch consisted of 191g recycled glass, 64g coloured glass, 22.5g CMC, and 22.5g wallpaper glue, with the careful addition of water to ensure a homogeneous composition in each body.

These meticulously crafted batches served as the foundation for assessing the throwing characteristics and coloration potential of the glass bodies, providing valuable insights into the effectiveness of the formulated recipe in the creative process.

Figure 18 Glass body creation.



6.2 Wheel-throwing technique

Throwing the body glass on the pottery wheel works as if it is clay (Figure 19):

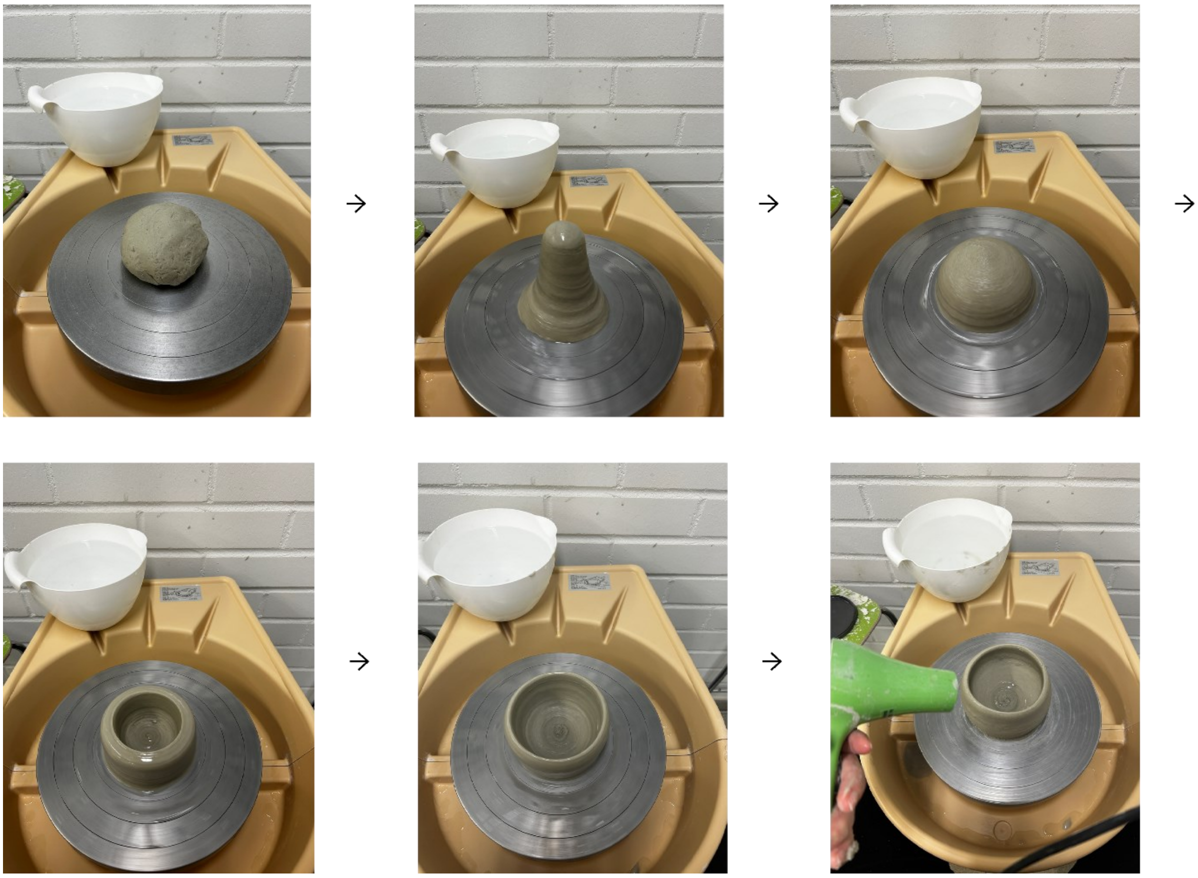
Seal the Body to the Bat: Secure the bat onto the wheel and forcefully attach a glass body ball to the centre of the bat. As the wheel spins, use your index finger to seal the glass body to the bat until the body is securely attached.

Centre the Body: Cone up and cone down to centre the clay on the wheel. Push the glass body up into a cone shape with your hands, then press down with a flat palm while holding the body's side to prevent protrusion. Repeat until cantered, adding water as needed.

Make an Opening: Create a divot in the centre using thumbs, acting as a centre guide. With one hand, slowly push down towards the bottom, adding water throughout.

Shape the Body: Place fingers inside the opening and the other hand outside. Using the flat side of your fingers, push the glass body outward without creating ridges. Stabilize the wall inside, create an indent at the base with an outside finger, and slowly move the body up the wall.

Figure 19 Throwing process.



6.3 Explorations and variations

In the initial phase of my research, I chose to work with 100g segments of clay on the pottery wheel to assess their feasibility and the resultant size of the formed pieces. Opting for this specific weight provided a balanced and manageable starting point for exploration, allowing for ample practice and experimentation in the context of my thesis. Despite encountering numerous setbacks during the wheel-throwing process and experiencing more failures than successful pieces, I persevered and eventually produced six foundational pieces for kiln testing using the basic clay body (Figure 20).

Attempting to scale up, I experimented with 300g and 400g portions of clay on the wheel. While successful in shaping the clay during the wheel-throwing stage, challenges arose during the subsequent removal and drying phases. Instances of collapse during extraction and shelf drying were notable issues. Despite these challenges, I incorporated these pieces into the kiln testing program to gather valuable insights.

Recognizing the limitations of working with the wheel for larger pieces and acknowledging the need for a new thesis to explore glass body in-depth, I redirected my focus to testing throwing bodies in various colours. This approach enabled me to observe how different colours behaved in the kiln, noting variations in shrinkage, shine, and smoothness.

As I transitioned to throwing on the wheel, I adopted a deliberate approach, first familiarizing myself with the properties of the glass body. This included understanding the quantity required for each piece and gaining insights into the overall working process. From instances where no finished pieces resulted, I learned the importance of avoiding overly thin sections, as they are prone to breakage during handling or hinder the formation of certain shapes due to collapse.

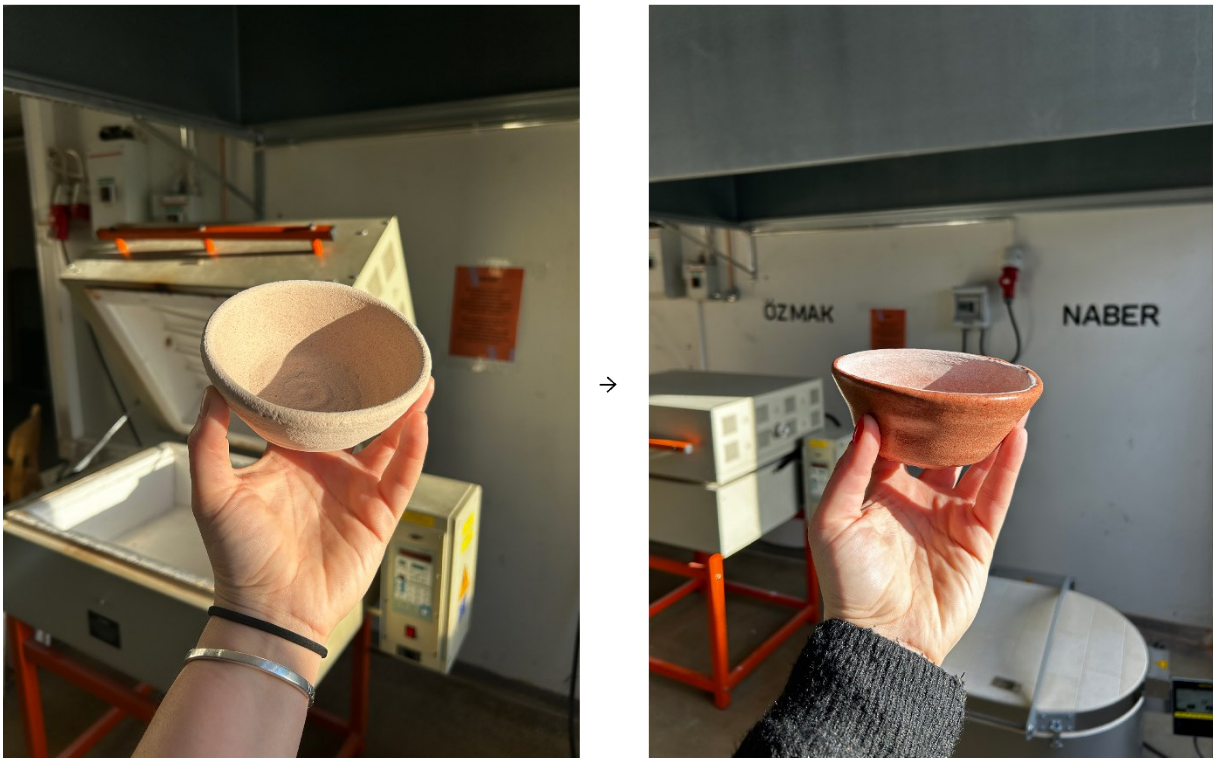
Figure 20 Dry test pieces.

Upon realizing the limited variation achievable with white-coloured glass shapes, when attempting various shapes, they tend to collapse during the drying phase I made the decision to explore a spectrum of colours. My aim was to deepen my understanding of their behaviour both on the pottery wheel and within the kiln.

Figure 21 Green glass piece before and after the kiln.

The outcome of this yellowish tone results surprising nuances in several aspects (Figure 21). Despite employing an identical kiln program for all colours, this particular shade exhibited a significant degree of melting. Nevertheless, the resulting vivid coloration was a delightful revelation. Its surface boasts a smooth, pristine finish, offering a pleasing tactile experience. To optimize future firings with this colour, adjustments to the kiln program are advisable, including a reduction in peak temperature and, potentially, a more expedited ascent without prolonged pauses along the way.

Figure 22 Orange glass piece before and after the kiln.

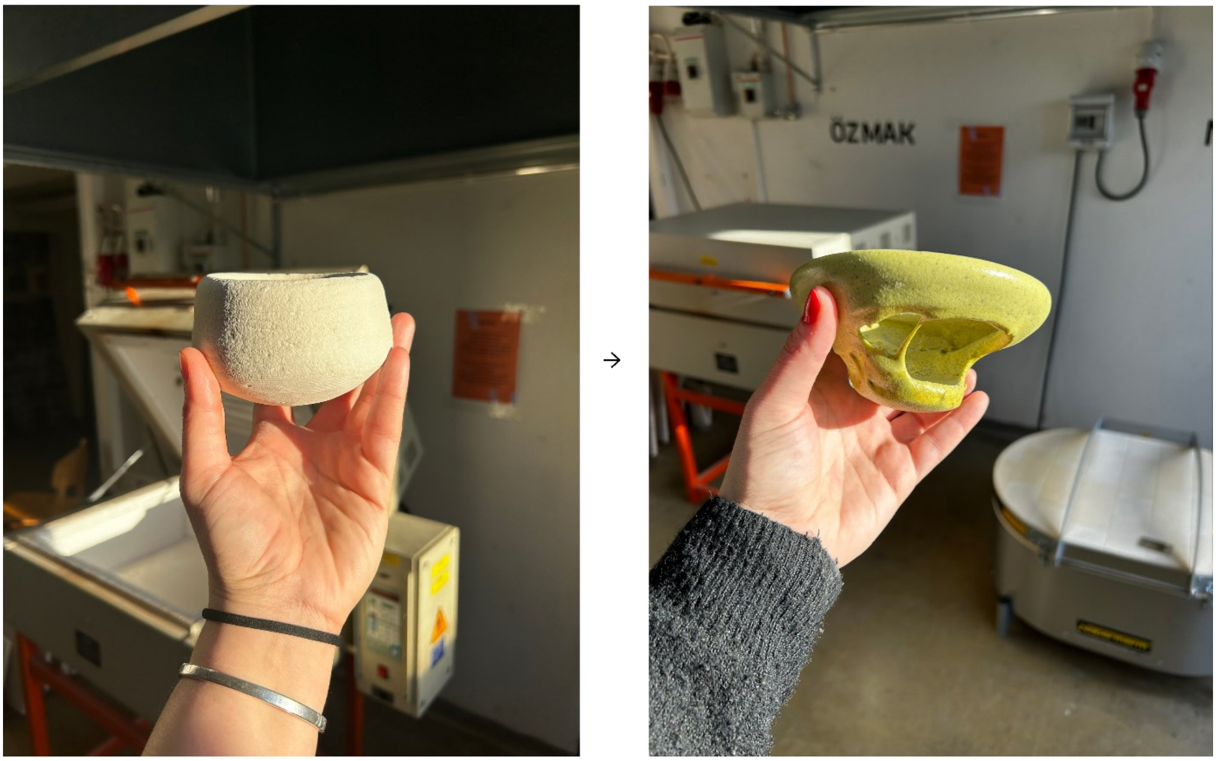


The orange colour appeared more reddish than anticipated (Figure 22). There was a slight breakage at the bottom, which should be easily remedied through polishing in the cold workshop, leaving a smooth and clean surface with a pleasant texture. Given these outcomes, I wouldn't make significant changes to the kiln program in future firings, perhaps just considering a slight reduction in the waiting time at the peak temperature.

Figure 23 Pink glass piece before and after the kiln.

This pink tone caught me off guard; unlike the others, it didn't melt as expected, resulting in a rougher surface texture post-kiln (Figure 23). Its colour lacked the vibrancy seen in the others, falling short even in comparison to white. In response, I would opt for the opposite approach, raising the peak temperature and potentially extending the hold time to 20 minutes. However, to pinpoint the optimal temperature, further experimentation with additional test pieces is necessary, given its resistance to melting at 840 degrees, which is already considered quite high for glass.

Figure 24 Yellow glass piece before and after the kiln.



The yellowish hue, despite its surface appearing smoothly melted and clean, it unexpectedly broke in the kiln (Figure 24). Upon closer examination, it seems the breakage occurred during the program, leaving fractured portions that lack the same smoothness as the rest. Interestingly, a similar fate befell the purple piece, which shared the kiln with it. This raises suspicions about potential disruptions during the firing process – perhaps the kiln was opened prematurely, or electrical issues arose over the weekend, causing the breakage. Before hastily adjusting the kiln program, it's prudent to conduct further investigations. I intend to create another test piece using the purple colour to determine whether the issue lies with the colour itself or if external factors are at play. Understanding the root cause is essential before making any modifications to the firing parameters.

Figure 25 Purple glass piece before and after the kiln.

The vibrant purple tint emerged from the kiln with a pleasing brilliance, its surface smooth and inviting to the touch (Figure 25). However, my excitement was abruptly tempered by the discovery that it had fractured entirely upon removal. Intriguingly, I observed that this shade possessed a lower melting temperature compared to its green counterpart, evidenced by the smoother breakage. This anomaly led me to ponder whether external factors, such as an untimely kiln opening or electrical disturbances, might have contributed to the mishap. Prior to making any adjustments to the kiln program, I resolved to conduct a thorough investigation. Another test piece, this time using the green pigment, would serve to elucidate whether the issue lay with the colour or external variables. Considering the disparity in melting behaviour between the purple and green hues, I contemplate a slight reduction in peak temperature for future firings of the purple pigment.

7 Reflection

This thesis journey has been a profound and unexpected experience, marking a significant advancement in my glass working skills and the exploration of innovative techniques.. Throughout the process, I encountered moments of both triumph and challenge, yet ultimately surpassed my initial expectations.

Embarking on this thesis journey to discover the optimal recipe for throwing glass on the pottery wheel, I am convinced that this formula holds immense potential for further exploration and application in various techniques, contributing to the combination of glass into our daily lives. Indeed, glass stands as one of the most remarkable materials to engage with, appearing from easily available basic components in our environment, possess recyclability, reusability, and relentless durability.

The initial inquiries that power up my project have now been comprehensively addressed and substantiated. Could glass truly be thrown on a pottery wheel? The affirmative echoes of my thesis resound – yes, it is practicable. Yet, unlike clay, glass demands a more delicate touch, its inherent fragility posing challenges in realizing intricate designs. Nevertheless, this should not deter us; rather, it underscores the need for further refinement in our techniques and recipes to fully use this method's potential.

Can glass be moulded alike clay? I firmly affirm that it can. However, meticulous attention must be paid to a certain degree to both the material and our processes. Not all glass powders are created equal; their fineness is crucial, and they pose a risk during handling. While some techniques, like slip casting, necessitate additional development, others such as coil, slab, pinch, or even 3D printing hold promise for successful implementation.

Addressing the sustainability aspect of glass clay, its creditable eco-competence shine through. Utilizing recycled glass and culminating in a final product that remains fully recyclable ensures a closed-loop system. The inclusion of adhesive within the mixture presents no obstacle to recycling, as it combusts during firing, leaving behind pure, recyclable glass.

The culmination of this aim is reflected in two distinct categories: pieces crafted from white glass and those devoted to vibrant colours. Each category offers unique insights invaluable to both my learning journey and the thesis itself. However, it is essential to acknowledge that while the final pieces demonstrate considerable progress, achieving absolute perfection would necessitate a more extensive investigation beyond the scope of this study.

Remarkably, the white glass pieces emerged from the kiln with minimal flaws, with any imperfections easily remedied post-firing. Yet, it was the coloured pieces that yielded the most unexpected results upon removal from the kiln. Despite utilizing the same kiln program as the white pieces, some of the coloured pieces underwent significant distortion, rendering them unusable, while others exhibited unforeseen improvements.

An intriguing observation surfaced during the examination of the coloured pieces: the extent of melting varied in direct correlation with the brightness of the colour employed. This phenomenon, previously unexplored, presents a captivating avenue for further investigation into the intricacies of kiln behaviours. Particularly, while the lightest colour maintained their form impeccably, the brightest and most colourful ones experienced considerable melting—an outcome contrary to my initial assumptions based on previous test pieces. This revelation underscores the necessity of adapt kiln programs to suit the unique melting temperatures associated with each colour variant.

I take great pride and satisfaction in achieving my primary objective: improvement of a suitable glass clay recipe conducive to pottery wheel applications. The development of working with glass on the pottery wheel, even if challenging, has proven to be a rewarding attempt, affirming that with patience and dedication, one can produce captivating and vibrant pieces.

Given the luxury of time, I would eagerly dig deeper into the implication of colour variations, fine-tuning the kiln programs to adapt to each tone. Moreover, I will be passionate about develop my exploration into the multiple techniques offered by glass clay, with a particular interest in the uncharted territory of 3D printing.

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Appendix 1. Thesis Data Management Plan

For my thesis, I relied solely on publicly available information, saving any need for interviews or data requiring security measures, the work does not contain sensitive personal data or confidential information. The ownership of both the thesis and its findings rests with me as the test pieces in my own archives for one year after the completion of this thesis. However, I am eager to contribute to future research and experimentation by offering my thesis to HAMK. Should it serve as a foundation for further studies or experimentation, I kindly request to be acknowledged as a reference.