FEEL THE WAX

A material experiment on the reaction between wax liquid and water

Shengxiang Shi
Master Thesis

LUNDS UNIVERSITET

Feel the wax - A material experiment on the reaction between wax liquid and water
Shengxiang Shi

Degree Project for Master of Fine Arts in Design
Main Field of Study: Industrial Design
Lund University, School of Industrial Design
Department of Design Sciences

Supervisor: Therese Eklund, Lecturer
Examiner: Per Liljeqvist, Senior Lecturer

Print year: 2022
ISRN-number: LUT-DVIDE/EX--22/50593-SE

ABSTRACT

My thesis is a material experiment on the wax liquid and water reaction. I first saw the response between the wax liquid and water by coincidence. Then I decided to dig it, so I took it as my master thesis.

This thesis used a rigorous and scientific research process in my perceptual material experiment. I documented every detail so that I could rationally summarize and analyze it.

The goal is to find the inherent forming law of the reaction between wax liquid and water by representing the random results produced by it.
The application of some specific patterns produced during the experiment is also included together with the future business model.

To sum up, this is an attempt to start from the unknown and carry out perceptual exploration and experiment in the framework of rationality in the material experiment field.

KEYWORDS

Material experiment Wax Reaction Unique structure Unique pattern

ACKNOWLEDGEMENT

The most important thing I learned in this project is to throw myself into a vast uncertain situation.

Based on my previous education in China, I am a person who'd love to do something that I can predict in a very theoretical way. But this time, since it is my master thesis, my last student project, I also think I've changed a lot in two years of education here. So, I told myself that I should do something that I had never tried before.

At first, I know nothing about how the wax liquid will react with water. I don't know if it is valuable enough for a master thesis. I even don't know where it will lead me when I keep going.

The only thing I am sure of is embracing those uncertainties and finding my direction in many choices.

I learned more than design skills in my thesis and my two-year master's study.

I want to say thank you to my supervisor, Therese, examiner, Per together with Josef, Soren, Wenjia, Yifan, and all the people who have helped me before.

Thank you all a lot.

Table of Contents

Introduction

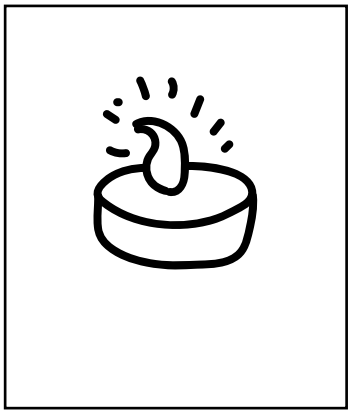
In this part, I want to clarify why I choose the wax liquid-water reaction material experiment as my master thesis and the reasons behind it, to further express my design philosophy.

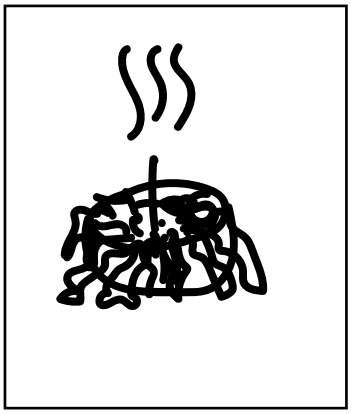
Background

Little story
I had this idea of doing the wax-water material experiment because of an accident.
It was at last winter. I lit an Ikea cup candle because the night was too long, and suddenly I didn't want it anymore. Instead of blowing it, I went to my restroom and put out the fire with tap water.
Then an amazing thing happened, the fire was put out together with a complex structure when the hot wax liquid met cool water.
This phenomenon impressed me greatly, and I kept it in mind until I began my thesis. So I decided to dive in and find out if there is any exciting stuff behind this phenomenon.

Daily life observer
As a designer, I am interested in everything that happens around me. And I am sensitive to any unusual happens in my daily life and turn it into my design or take that as a new opportunity if possible.

Philosophy
And I love that poetic stuff, and I believe each tiny change could make our life better.
So this time, based on my tiny observation last winter, I decided to take this material experiment as my master thesis, trying to find out some possibilities behind it. I have no idea what it will become when I start this project, and I love this process of everything being uncertain and becoming clearer when I spend more time on it.





■ Design questions

How does this phenomenon happen?

Can I control it in some way?

Does it have any value?

What is the future development direction?

How does this phenomenon happen?

Research 1.0

To answer the first question, in this part, I did some primary desktop research, trying to get a general understanding of candles and wax industry.

■ Desktop research

Wax characters

Solid at room temperature; liquid at higher temperatures

Primarily hydrocarbon in structure

Water repellent; insoluble in water

Smooth texture; buffable under slight pressure

Low toxicity; low reactivity

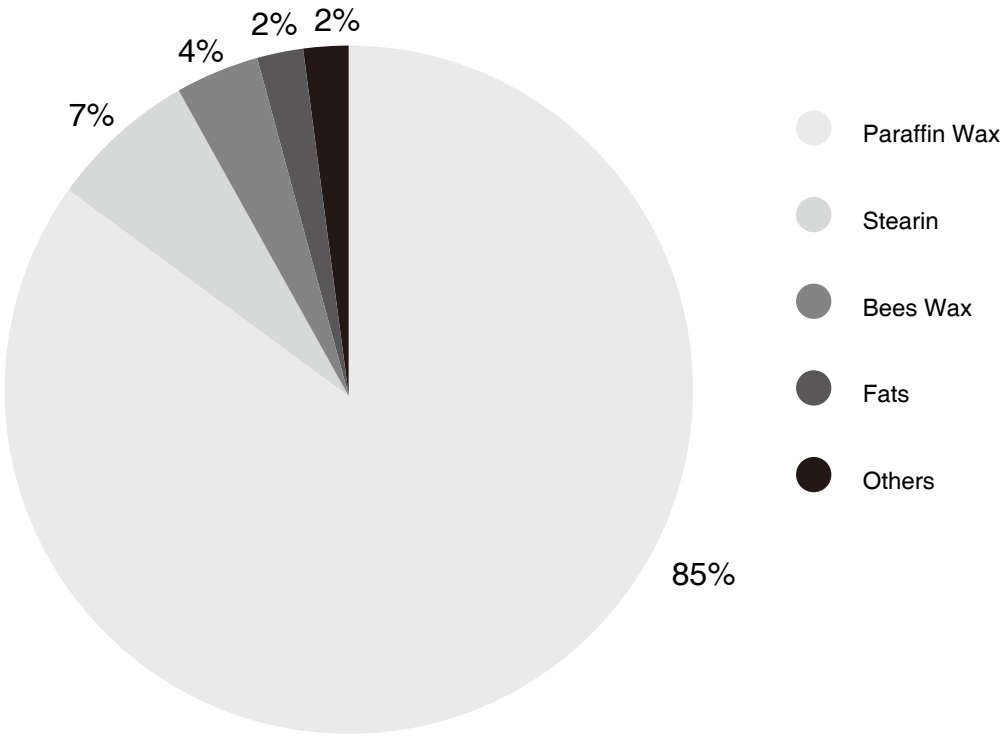
Low odor

Publiced on the NCA(National Candle Association) wbbsite

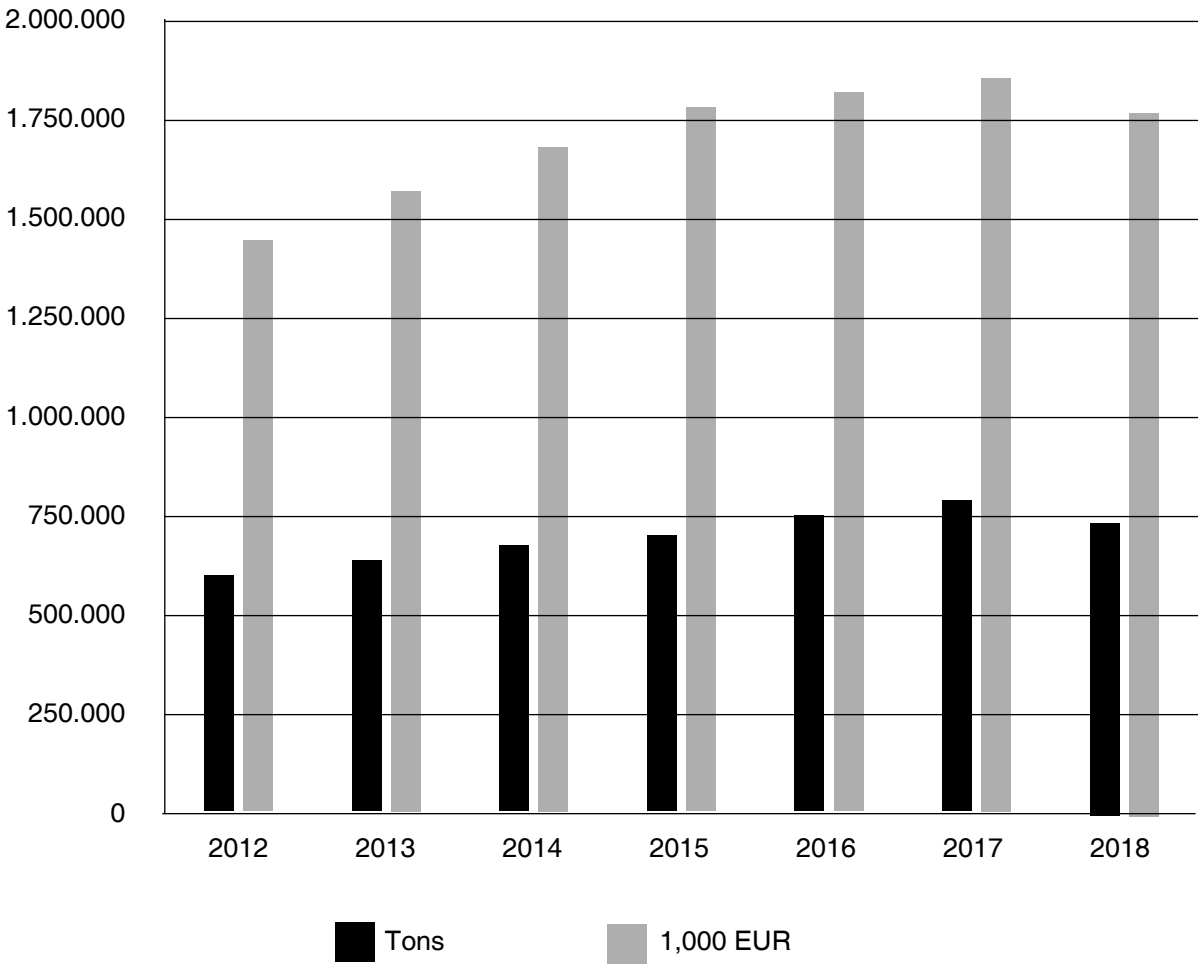
Raw Materials for Candle Manufacturing

Paraffin wax	Bees wax	Stearin	Hardened fats
petroleum/coal /natural gas	metabolite of honey bees	hardened oils and fats of vegetable and animal origin	hardened oils and fats of vegetable and animal orgin
saturated linear and branched as well as cyclic hydrocarbons	wax esters wax alcohols wax acids	mixture of fatty acids (palmitic acid/stearic acid)	mixture of triglycerides and fatty acids
soft ductile hard	sticky kneadable ductile	hard brittle	hard to ductile at low melting point
all processes of candle manufacturing (drawing,pouring, pressing,dipping, extruding)	pouring(without blending)	pouring pressing	pouring
1830	used in candles since 8th century B.C.	1824	used as tallow since 8th century B.C.hardened substance since mid 1900s

Share of Raw Materials for Candles



Comsumption of candles in the EU



Market research shows that Europeans comsume a huge amount of candles every year

data from European Association ASBL

■ How does this phenomenon happen

As we know, wax is solid at room temperature
but liquid at a higher temperature.

When I pour the cold water into hot wax liquid, some
wax liquids will quickly convert to solids since they
are cooled down by the cold water immediately.

While water has specific kinetic energy when it falls
from a height, it will change the shape of that part
of wax liquid which becomes solid immediately.

And the rest will gradually cool down and become a solid.

This is the general principle of this principle.

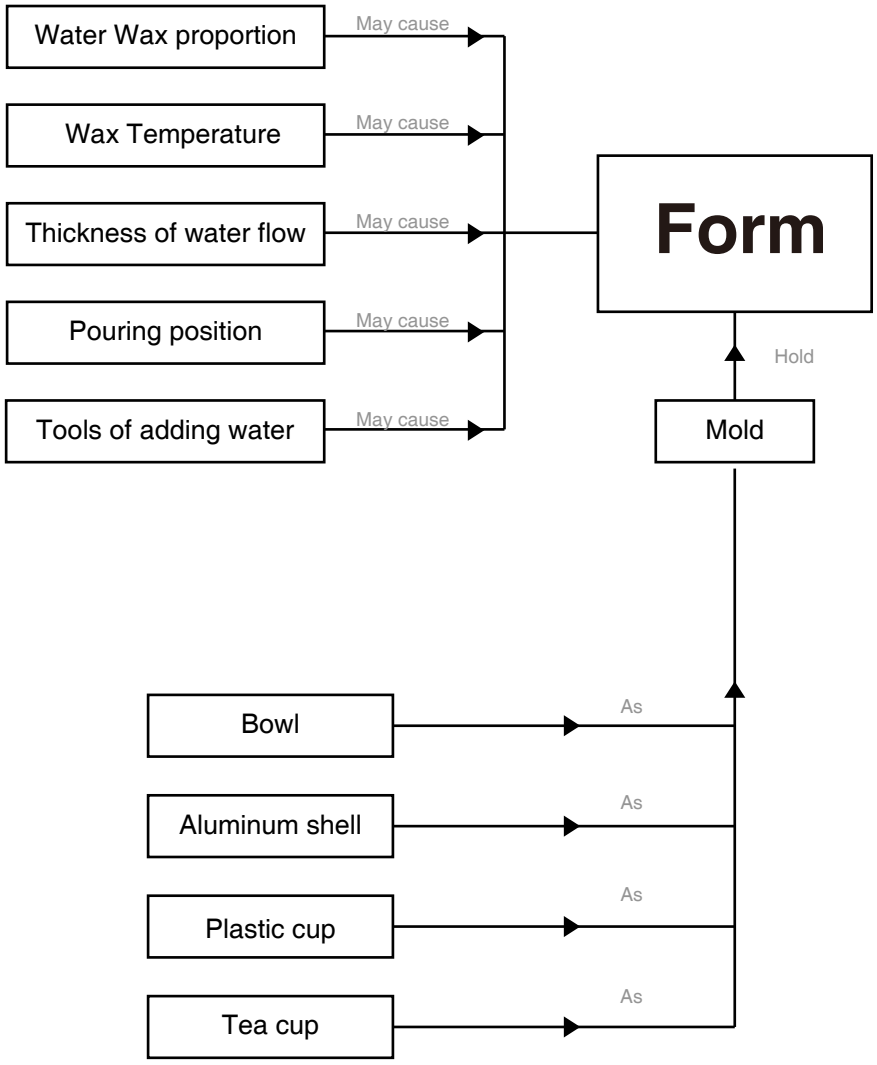
Can I control it in some way?

Experiment

After I figured out how this phenomenon happens, I began to seek the forming law of this phenomenon and find a way to control it.
In this part, I experimented first on a small scale for some quick discovery and analysis by using the control variable method.
After getting several general conclusions, I improved my experiment process and experimented with this on a big scale. If some of my findings still work on a big scale, then it will prove that, to some extent that I had found some way to control its shaping, which answers my question, “Can I control it in some way?”

■ Small scale

Design the experiment



Experiment process

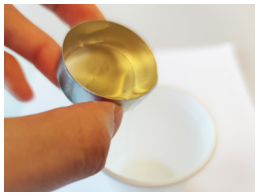
Make a shelf

Bake a candle with another candle

Take out the wick

Put the candle on the insulation pad to cool

Add water



Pour out part of the wax liquid

Decrease wax liquid

Bigger mold

Bowl

Tea cup

Plastic cup

Overflow

Pour water into the wax liquid

Prepare an aluminum shell filled with water

Experiment result

Control variable method

change: **Water-Wax liquid proportion**

keep:
- Wax Temperature
- Pouring position
- Thickness of water flow
- Tools of adding water

change: **Wax Temperature**

keep:
- Water-Wax liquid proportion
- Pouring position
- Thickness of water flow
- Tools of adding water

change: **Thickness of water flow**

keep:
- Wax Temperature
- Pouring position
- Water-Wax liquid proportion
- Tools of adding water

change

Pouring position

keep

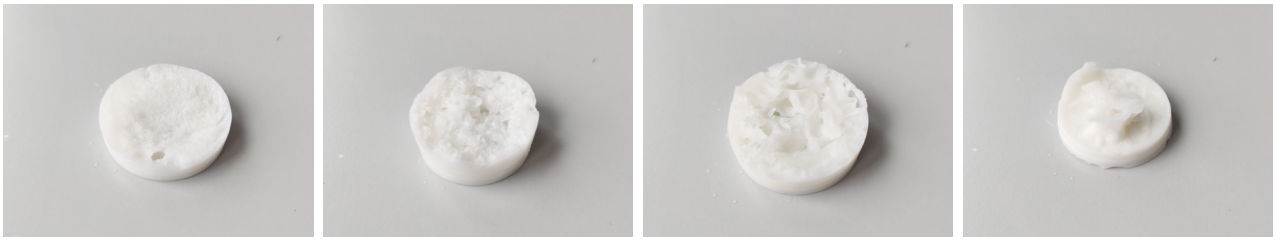
- Wax Temperature
- Water-Wax liquid proportion
- Thickness of water flow
- Tools of adding water

change

Tools of adding water

keep

- Wax Temperature
- Pouring position
- Thickness of water flow
- Water-Wax liquid proportion



Reflection

- Wax temperature, water wax proportion, pouring position, thickness of water flow, tools of adding water do affect the final form

- The difference between the substances poured into the wax liquid may also affect the final form

- Will the results obtained in a small amount of wax liquid be the same in a large amount of wax liquid?

- More candles for the experiment

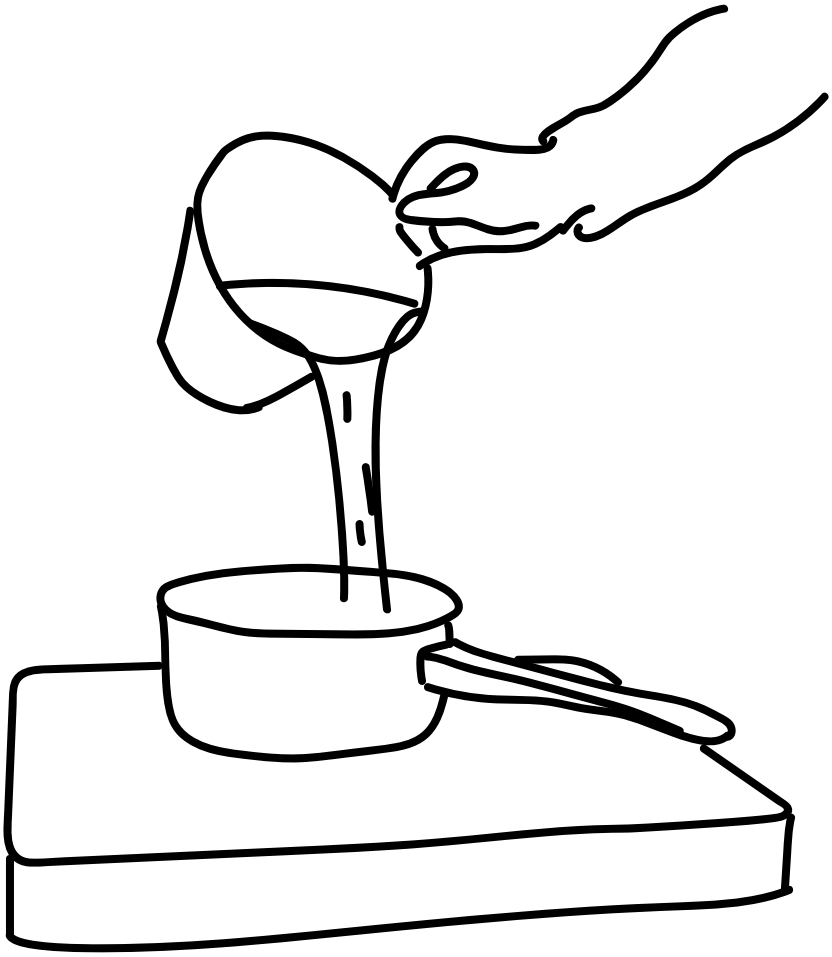
- More efficient heating tools

- More precise experimental operation steps
  (for example: Using a thermometer to measure the temperature instead of calculating the cooling time)

Large scale

First, I want to develop a more efficient tool to help me to add water to wax liquid.

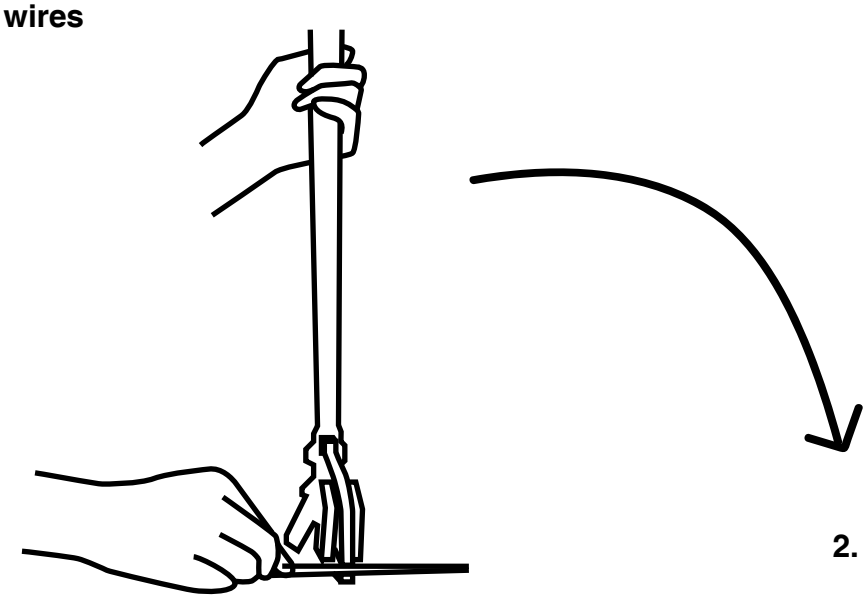
Manual proposal



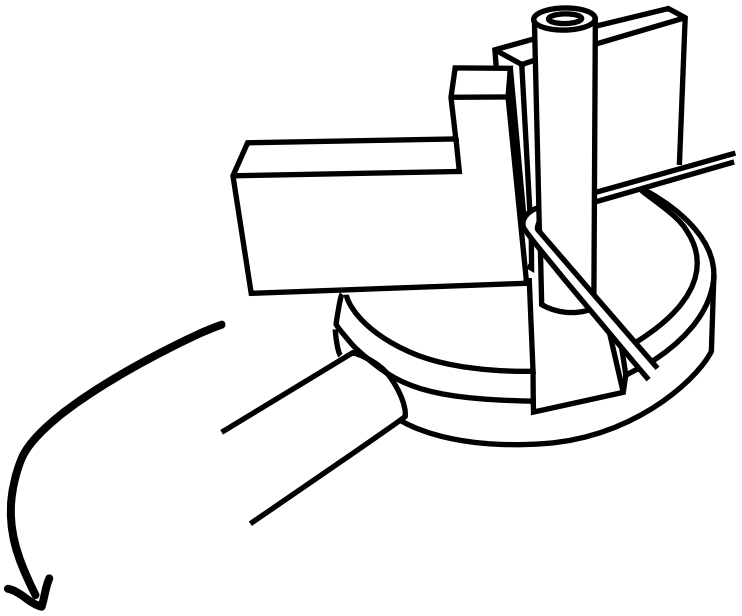
Pour water manually

Metal support proposal

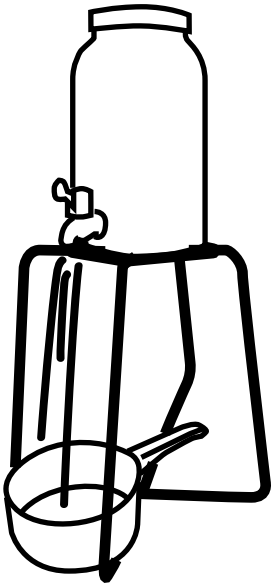
1. Cut wires



2. Bend them

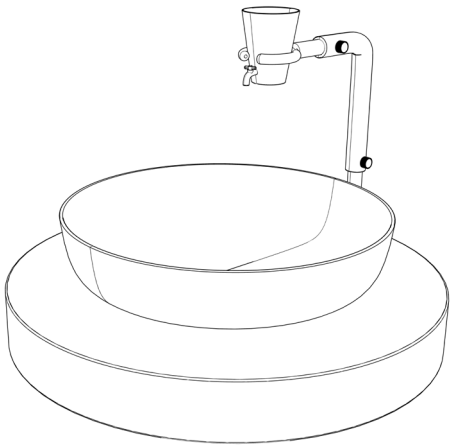


3. Welded into a support frame

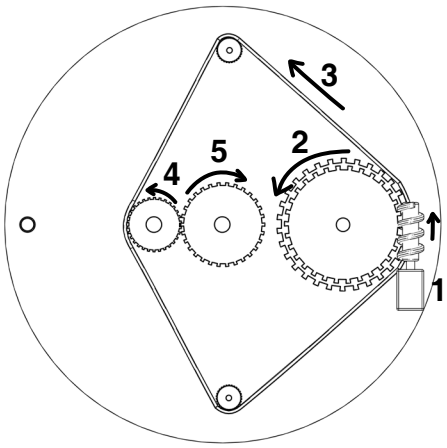


Arduino proposal

1. Overview

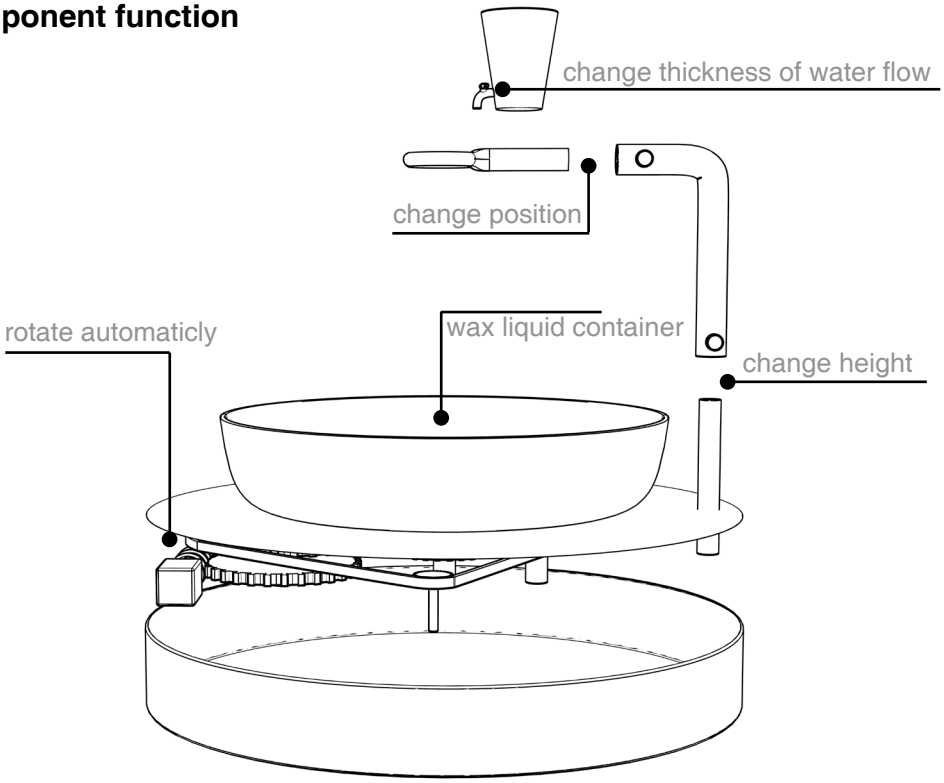


2. Gear structure



1. Arduino motor
(Provide initial kinetic energy)
2. The vertical gear drives the horizontal gear to rotate
3. Belt driven by gear
4. The moving belt drives the gear to rotate
5. The gear drives the gear to rotate

3. Component function

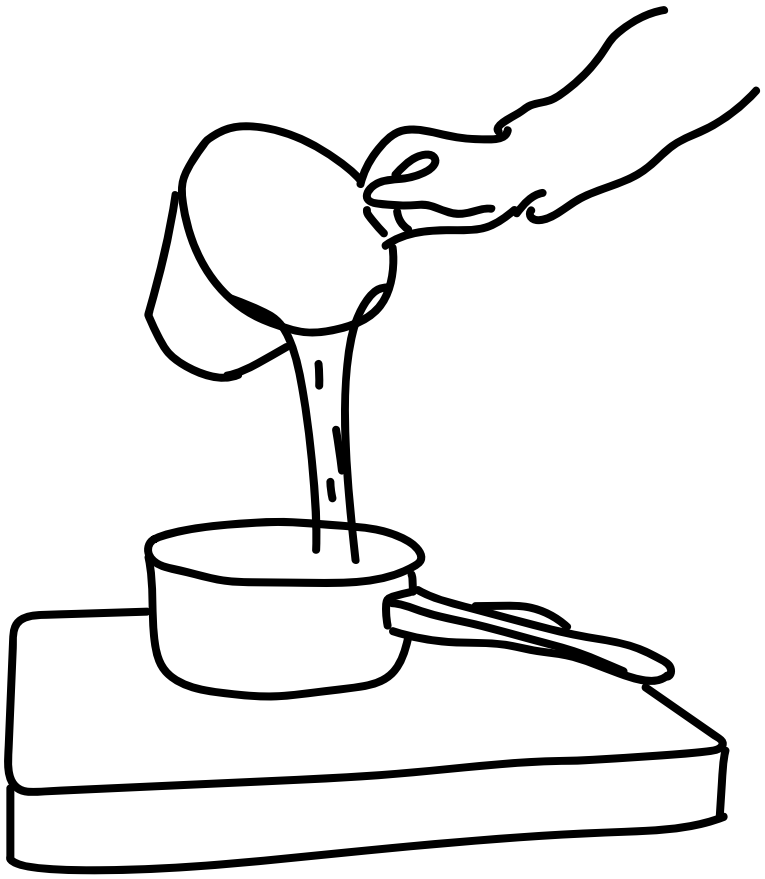


At last, I choose the manual proposal.

First, because of the time limitation, I have to focus more on the material experiment but not on the tool.

Second, it is still an exploring phase for me, so it doesn’t need to be that accurate.

In the future, if I decide to make that in a way like an assembly line, then these machine proposals above would be valuable.



Checking list

Variables

- [x] Wax temperature
- [x] Water temperature
- [x] Water-Wax liquid proportion
- [x] Way of pouring water
- [x] Liquid category
- [x] Thickness of water flow
- [x] Height of pouring water
- [x] Others

Tools

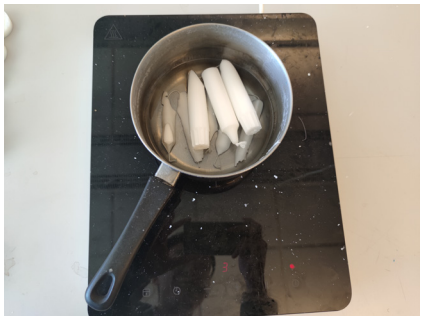
- [x] Thermometer
- [x] Electromagnetic furnace
- [x] Metal pot
- [x] Spray can
- [x] Plastic bottle
- [x] Measuring cup
- [x] Oil pot

Material

- [x] Stearin candles from IKEA

Experiment process

1



Melt the candle in the pot on the oven

2

Pour the wax liquid into the measuring cup and measure its volume

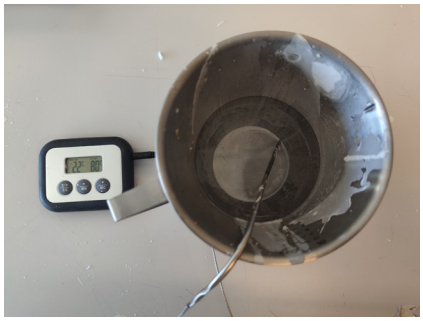
3

Pour the wax back into the pot

4

Prepare the same volume of water in the measuring cup

5



Measure and record the water temperature

6

Cool the wax liquid to a spcific temperature, record it

7

7. Pour water into wax liquid

8

	Wax liquid temperature(℃)	Water temperature(℃)	Height of pouring water(cm)	Proportion of water and wax	Thickness of flow	Experimental phenomenon	Experiemental purpose	Experienmental conclusion
N0	70	22	30	1:1	normal	Heat surge phenomenon		
N1	70	22	30	1:1	normal			
N2	70	23	30	1:1	super thick (from one side)			
N3	45	23	30	1:1	normal			
N4	80	22	30	1:1	normal			
N5	80	22	40	1:1	normal (change flow position for many times)			
N6	70	22	40	1:1	normal (perfect)			
N7	80	22	40	1:1	normal			The high-temperature wax liquid is not conducive to the formation of the upwelling hole of the hot wax liquid. If you want to have the structure of upper and lower layers, it is better to have the wax liquid temperature of 70 ℃ without changing the water temperature
N8	54	22	40	1:1	normal		Explore the activity of wax at 50℃	Compared with 70 ℃, the activity of wax liquid at 50 ℃ is very low, which is not conducive to the diffusion of wax liquid in the upper layer after the occurrence of heat surge, resulting in the failure to form a "bubble like" upper layer
N9	63	22	40	1:1	normal		Explore the activity of wax at 60℃	The activity of wax at 60 ℃ is also not too high. Preliminary conclusion: when the water temperature is 22 ℃, **the wax liquid at 70 ℃ is the best tempreture to form a circular bubble like upper shell. The wax liquid at 60 ℃ is conducive to the formation of irregular (small part) bubble like upper shell** At the same time, constantly changing the position when pouring water helps to seal more hot wax whcih can lead to a more beautiful (uniform) bottom with a narrow mouth of hot wax.
N10	70	22	40	1:1	normal (change flow position for many times)		Explore the influence of the width of the hole on the heat surge phenomenon	A narrower hot wax mouth is obtained by changing the pouring position. Experiments show that the width of the hole is not the decisive factor for the formation of the upper "bubble like" upper layer **As long as the temperature and activity of the wax are enough, the heat surge phenomenon always happens no matter how small the hole is.**
N11	70	22	90	1:1	normal		Explore the influence of water height on molding	
N12	70	22	150		normal		Explore the influence of water height on molding	**Height has an impact on the final shape because of the water force brought by the height. On the other hand, the forming structure of hot wax has no qualitative change when we change the height of the water flow.**
N13	70	92	40	1:1	normal	Become a solid piece	Explore the interaction of hot water with hot wax liquid	
N14	54	2（mix with large ice）	40	1:1	normal	The heat surge disappears directly and the whole becomes a block directly	Explore the influence of low wtaer tempreture on molding	
N15	54	2 (mix with small ice)	40	1:1	normal			
N16	120	4 (mix with small ice)	40	1:1	normal	The hot wax liquid cannot be cooled quickly and eventually becomes a lump	explore the reaction phenomenon between high temperature wax liquid and	
N17	100	5	40	1:1	normal	The heat surge phenomenon appears again which brings the uppper and lower layer		
N18	76	4（mix with small ice）	40	1:1	normal	The heat surge phenomenon still exists but the activity is very low which makes the upper layer fail to form a perfect circular "bubble like" shape		Quite similar to the result of low tempreture+nomal tempreture water.
N19	60	4	40	1:1	normal	The heat surge phenomenon disappear and becomes a lump of wax eventually	Keep reducing the tempreture of wax liquid when keep the tempreture of water.	
N20	70	4 (mix with small ice)	40	1:1	normal			
N21	63	4	40	1:1	super thin	Flower like texture	Explore the influence of the thickness of water flow on the final shape.	
N22	60	4	15	1:1	thick	Radial texture	Explore the influence of water flow height and thickness on forming under ice water conditions	The thickness of water flow affect the fianl shape a lot. **Thin water flow will cause a flower like pattern while thick water flow will cause a rdial pattern**
N23	54	4	15	1:1	thin	After the thin water flow enters, it will form a circle of diffusion at the bottom, like a flower like texture		
N24	60	22	15	1:1	thin		Explore the influence of normal tempreture thin water flow on molding	**Normal temperature water cannot cool the hot wax liquid immediately.** Although it also has the flower like textures at the bottom in the initial stage, it is very shrinkage (the ability of normal temperature water to cool and solidify the wax liquid is limited.) **And there will be a circle of very large holes on the surrounding edges, which will eventually lead to heat surge phenomenon which will cover the flower like texture finally.**
N25	60	22	15	1:1	thick		Based on the result of N24, explore the ability of normal tempreture water to cool down the hot wax liquid.	Compared with N24, due to the huge motivation brought by thick water flow, the opening around the molding is smaller, but as the previous N10 experimental conclusion, the width of the opening does not determine whether the heat surge phenomenon occurs or not. Finally, the heat surge phenomenon still occurs which will block the texture at the bottom.
N26	60	4	15	1:1	thick	The radial texture is obvious, and the heat surge phenomenon disappears	Explore the influence of water tempreture on molding by comparing to the result of N25	**Low tempreture eliminate the heat surge phenomenon which helps to the show the bottom texture.**
N27	60	4	150	1:1	normal	Several deep holes at the bottom together with radial texture.	Explore the performance of ice water at extreme heights (water has great kinetic energy)	
N28	62	12	15	1:1	normal		Explore the influence of different water tempreture on molding.	**It is in the middle of ice water and normal temperature water. The heat surge phenomenon exists, but the shrinkage of the top is very obvious**
N29	55	40	15	1:1	normal	Many spherical wax bubbles are formed at the bottom, but they are finally covered by the upper layer because of the heat surge phenomenon.		**This is a totally new phenomenon (texture)**
N30	60	40	30	1:1	normal	It is a mess		Water with high kinetic energy is not suitable to reach the N29 phenomenon
N31	60	40	15	1:1	normal		Try to reproduce the N29 phenomenon	Failed. Some wax bubbles were observed during the filling process, but the number was small. It was difficult to find the traces of their existence after the final cooling
N32	55	30	15	1:1	normal		Try if 30 ℃ is easiler to get the N29 phenomenon	NO. Get the similar result to the N10
N33	60	40	15	1:1	thin		Try to get the wax bubble by changing the thickness of water flow	**It failed.** During the cooling process, most of the wax was poured out in an attempt to retain the wax bubble. Only one defective product is left.
N34	56	2	15	1:1	Keep stirring the wax liquid with a stick to create a vortex, and then take the opportunity to pour water	Vortex texture		
N35	65	/	/	1:1	add some ice into directly	Several big holes in the lump of wax		
N36	65	15	15	1:1	Water rich in foam(Soapy water)	A deep hole in one area		**Foam has weight, they will gather in one area and then press the area.**
N37	54	14	15	1:1	thin (Shower head water flow)			
N38	60	14	15	1:1	thick (Shower head water flow)			
N39	55	14	15	1:1	Spray a very fine mist with a spray can			At first, the surface was very flat, but due to the water pressure attached to the watering can, some planes were broken, and the surface began to fluctuate due to thermal expansion and cold contraction
N40	60	4	/	1:1	Inject ice water into the hot wax liquid with a pointed nozzle oil pot			The experimental results are not very ideal. During this period, the injection of water was interrupted many times. The hot wax liquid solidifies directly when encountering ice water and seals the spout. I had to pick up the oil pot and poke the mouth of the pot with a stick before injection.
N41	63	6	/	1:1	Inject ice water into the hot wax liquid with a pointed nozzle oil pot		Redo N40 process. This time trying to squeeze the water in one time to avoid the N40 suitation I encoutered	When the oil pot is inserted into the hot wax liquid, it is very easy to appear the same phenomenon as N40. However, after paying attention, the situation has improved slightly, but it is still blocked badly.
N42	60	14	/	1:1	Inject cool water by insert the shower head into the hot wax liquid	The shower head was directly stuck by the solidified wax.		
N43	54	20	15	1:1	Keep changing positions to pour egg liquid (7 eggs)			The density of egg liquid is so high that it will not spread around like water when poured into hot wax liquid. It will continue to gather in one place and slowly spread around. A large circle of wax will remain around and fail to react with the egg **It's very similar to dripping blood into water.**
N44	60	10	15	0.5 egg liquid+0.5water:1 wax liquid	Keep changing positions to pour egg liquid		Add water into egg liquid to see the difference.	It's quiet similar to the phenomenon of pouring pure egg liquid into hot wax liquid. **It's still very silky when pouring, and won't splash around like water.**
N45	50	10	15	0.5 egg liquid+0.5water:1 wax liquid	Pour egg liquid in circles			
N46	60	30	15	1:1	pour oil	After the oil is poured in, it will produce a lot of soft flocculent substances, which is a little disgusting.	Explore the interation of oil with wax liquid	
N47	60	4	15	1:1	normal (Add crayon crumbs into the water)	Explore some colorful possbilities.		
N48	70	4	15	1:1	Insert a pipe into the wax liquid and water it	Wax bubbles appears in the process, quiet similar to N29		
N49	70	4	15	1:1	Pour the wax liquid into the bottle and then pour water inside		Try to make a candle	

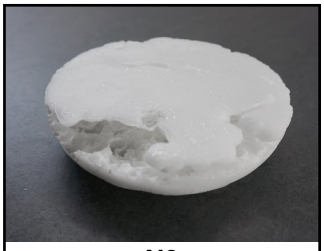
8. Record these experiment results

Experiment result

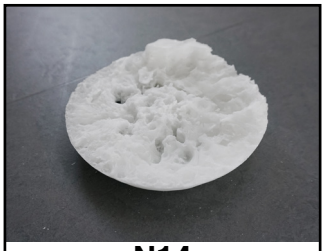
	Wax liquid temperature(℃)	Water temperature(℃)	Height of pouring water(cm)	Proportion of water and wax	Thickness of flow	Experimental phenomenon	Experiemental purpose	Experienmental conclusion
N0	70	22	30	1:1	normal	Heat surge phenomenon		
N1	70	22	30	1:1	normal			
N2	70	23	30	1:1	super thick (from one side)			
N3	45	23	30	1:1	normal			
N4	80	22	30	1:1	normal			
N5	80	22	40	1:1	normal (change flow position for many times)			
N6	70	22	40	1:1	normal (perfect)			
N7	80	22	40	1:1	normal			The high-temperature wax liquid is not conducive to the formation of the upwelling hole of the hot wax liquid. If you want to have the structure of upper and lower layers, it is better to have the wax liquid temperature of 70 ℃ without changing the water temperature
N8	54	22	40	1:1	normal		Explore the activity of wax at 50℃	Compared with 70 ℃, the activity of wax liquid at 50 ℃ is very low, which is not conducive to the diffusion of wax liquid in the upper layer after the occurrence of heat surge, resulting in the failure to form a "bubble like" upper layer
N9	63	22	40	1:1	normal		Explore the activity of wax at 60℃	The activity of wax at 60 ℃ is also not too high. Preliminary conclusion: when the water temperature is 22 ℃, **the wax liquid at 70 ℃ is the best tempreture to form a circular bubble like upper shell. The wax liquid at 60 ℃ is conducive to the formation of irregular (small part) bubble like upper shell** At the same time, constantly changing the position when pouring water helps to seal more hot wax whcih can lead to a more beautiful (uniform) bottom with a narrow mouth of hot wax.
N10	70	22	40	1:1	normal (change flow position for many times)		Explore the influence of the width of the hole on the heat surge phenomenon	A narrower hot wax mouth is obtained by changing the pouring position. Experiments show that the width of the hole is not the decisive factor for the formation of the upper "bubble like" upper layer **As long as the temperature and activity of the wax are enough, the heat surge phenomenon always happens no matter how small the hole is.**
N11	70	22	90	1:1	normal		Explore the influence of water height on molding	
N12	70	22	150		normal		Explore the influence of water height on molding	**Height has an impact on the final shape because of the water force brought by the height.** **On the other hand, the forming structure of hot wax has no qualitative change when we change the height of the water flow.**
N13	70	92	40	1:1	normal	Become a solid piece	Explore the interaction of hot water with hot wax liquid	
N14	54	2 （mix with large ice）	40	1:1	normal	The heat surge disappears directly and the whole becomes a block directly	Explore the influence of low wtaer tempreture on molding	
N15	54	2 (mix with small ice)	40	1:1	normal			
N16	120	4 (mix with small ice)	40	1:1	normal	The hot wax liquid cannot be cooled quickly and eventually becomes a lump of wax	explore the reaction phenomenon between high temperature wax liquid and ice water	

	Wax liquid temperature(℃)	Water temperature(℃)	Height of pouring water(cm)	Proportion of water and wax	Thickness of flow	Experimental phenomenon	Experiemental purpose	Experienmental conclusion
N17	100	5	40	1:1	normal	The heat surge phenomenon appears again which brings the uppper and lower layer		
N18	76	4（mix with small ice）	40	1:1	normal	The heat surge phenomenon still exists but the activity is very low which makes the upper layer fail to form a perfect circular "bubble like" shape		Quite similar to the result of low tempreture+nomal tempreture water.
N19	60	4	40	1:1	normal	The heat surge phenomenon disappear and becomes a lump of wax eventually	Keep reducing the tempreture of wax liquid when keep the tempreture of water.	
N20	70	4 (mix with small ice)	40	1:1	normal			
N21	63	4	40	1:1	super thin	Flower like texture	Explore the influence of the thickness of water flow on the final shape.	
N22	60	4	15	1:1	thick	Radial texture	Explore the influence of water flow height and thickness on forming under ice water conditions	The thickness of water flow affect the fianl shape a lot. **Thin water flow will cause a flower like pattern while thick water flow will cause a rdial pattern**
N23	54	4	15	1:1	thin	After the thin water flow enters, it will form a circle of diffusion at the bottom, like a flower like texture		
N24	60	22	15	1:1	thin		Explore the influence of normal tempreture thin water flow on molding	**Normal temperature water cannot cool the hot wax liquid immediately.** Although it also has the flower like textures at the bottom in the initial stage, it is very shrinkage (the ability of normal temperature water to cool and solidify the wax liquid is limited.) **And there will be a circle of very large holes on the surrounding edges, which will eventually lead to heat surge phenomenon which will cover the flower like texture finally.**
N25	60	22	15	1:1	thick		Based on the result of N24, explore the ability of normal tempreture water to cool down the hot wax liquid.	Compared with N24, due to the huge motivation brought by thick water flow, the opening around the molding is smaller, but as the previous N10 experimental conclusion, the width of the opening does not determine whether the heat surge phenomenon occurs or not. Finally, the heat surge phenomenon still occurs which will block the texture at the bottom.
N26	60	4	15	1:1	thick	The radial texture is obvious, and the heat surge phenomenon disappears	Explore the influence of water tempreture on molding by comparing to the result of N25	**Low tempreture eliminate the heat surge phenomenon which helps to the show the bottom texture.**
N27	60	4	150	1:1	normal	Several deep holes at the bottom together with radial texture.	Explore the performance of ice water at extreme heights (water has great kinetic energy)	
N28	62	12	15	1:1	normal		Explore the influence of different water tempreture on molding.	**It is in the middle of ice water and normal temperature water.** **The heat surge phenomenon exists, but the shrinkage of the top is very obvious**
N29	55	40	15	1:1	normal	Many spherical wax bubbles are formed at the bottom, but they are finally covered by the upper layer because of the heat surge phenomenon.		**This is a totally new phenomenon (texture)**
N30	60	40	30	1:1	normal	It is a mess		Water with high kinetic energy is not suitable to reach the N29 phenomenon
N31	60	40	15	1:1	normal		Try to reproduce the N29 phenomenon	Failed. Some wax bubbles were observed during the filling process, but the number was small. It was difficult to find the traces of their existence after the final cooling

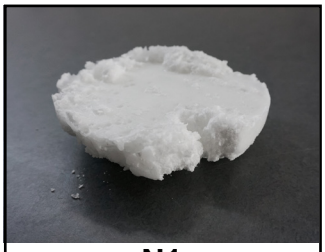
	Wax liquid temperature(℃)	Water temperature(℃)	Height of pouring water(cm)	Proportion of water and wax	Thickness of flow	Experimental phenomenon	Experiemental purpose	Experienmental conclusion
N32	55	30	15	1:1	normal		Try if 30 ℃ is easiler to get the N29 phenomenon	NO. Get the similar result to the N10
N33	60	40	15	1:1	thin		Try to get the wax bubble by changing the thickness of water flow	**It failed.** During the cooling process, most of the wax was poured out in an attempt to retain the wax bubble. Only one defective product is left.
N34	56	2	15	1:1	Keep stirring the wax liquid with a stick to create a vortex, and then take the opportunity to pour water	Vortex texture		
N35	65	/	/	1:1	add some ice into directly	Several big holes in the lump of wax		
N36	65	15	15	1:1	Water rich in foam(Soapy water)	A deep hole in one area		**Foam has weight, they will gather in one area and then press the area.**
N37	54	14	15	1:1	thin (Shower head water flow)			
N38	60	14	15	1:1	thick (Shower head water flow)			
N39	55	14	15	1:1	Spray a very fine mist with a spray can			At first, the surface was very flat, but due to the water pressure attached to the watering can, some planes were broken, and the surface began to fluctuate due to thermal expansion and cold contraction
N40	60	4	/	1:1	Inject ice water into the hot wax liquid with a pointed nozzle oil pot			The experimental results are not very ideal. During this period, the injection of water was interrupted many times. The hot wax liquid solidifies directly when encountering ice water and seals the spout. I had to pick up the oil pot and poke the mouth of the pot with a stick before injection.
N41	63	6	/	1:1	Inject ice water into the hot wax liquid with a pointed nozzle oil pot		Redo N40 process. This time trying to squeeze the water in one time to avoid the N40 suitation I encoutered	When the oil pot is inserted into the hot wax liquid, it is very easy to appear the same phenomenon as N40. However, after paying attention, the situation has improved slightly, but it is still blocked badly.
N42	60	14	/	1:1	Inject cool water by insert the shower head into the hot wax liquid	The shower head was directly stuck by the solidified wax.		
N43	54	20	15	1:1	Keep changing positions to pour egg liquid (7 eggs)			The density of egg liquid is so high that it will not spread around like water when poured into hot wax liquid. It will continue to gather in one place and slowly spread around. A large circle of wax will remain around and fail to react with the egg **It's very similar to dripping blood into water.**
N44	60	10	15	0.5 egg liquid+0.5water:1 wax liquid	Keep changing positions to pour egg liquid		Add water into egg liquid to see the difference.	It's quiet similar to the phenomenon of pouring pure egg liquid into hot wax liquid. **It's still very silky when pouring, and won't splash around like water.**
N45	50	10	15	0.5 egg liquid+0.5water:1 wax liquid	Pour egg liquid in circles			
N46	60	30	15	1:1	pour oil	After the oil is poured in, it will produce a lot of soft flocculent substances, which is a little disgusting.	Explore the interation of oil with wax liquid	
N47	60	4	15	1:1	normal (Add crayon crumbs into the water)	Explore some colorful possbilities.		
N48	70	4	15	1:1	Insert a pipe into the wax liquid and water it	Wax bubbles appears in the process, quiet similar to N29		
N49	70	4	15	1:1	Pour the wax liquid into the bottle and then pour water inside		Try to make a candle	


N0

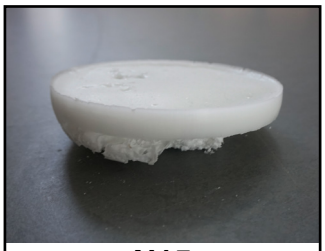

N7

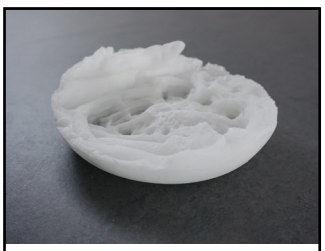

N14

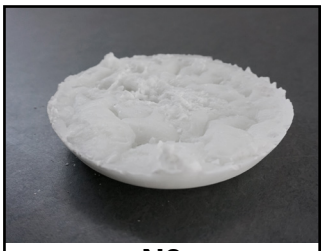

N21


N1


N8

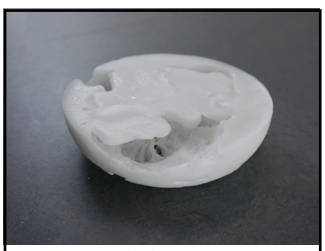

N15


N22


N2

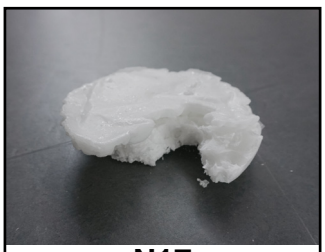

N9

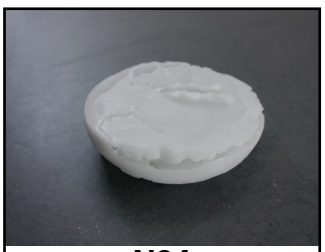

N16

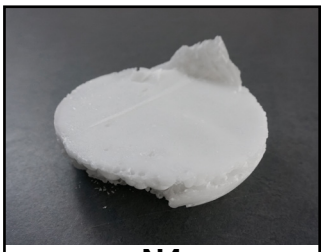

N23

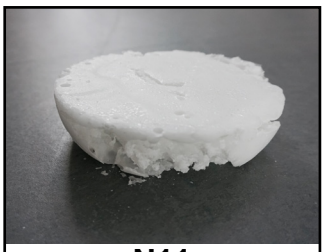

N3

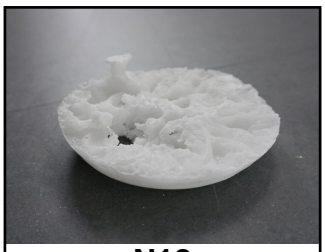

N10


N17


N24


N4

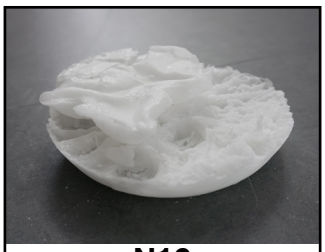

N11


N18


N25

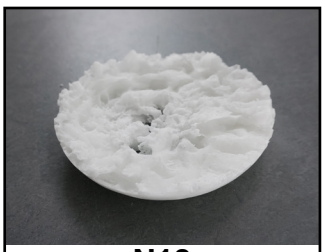

N5

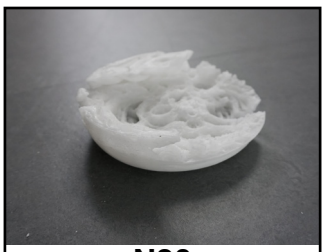

N12

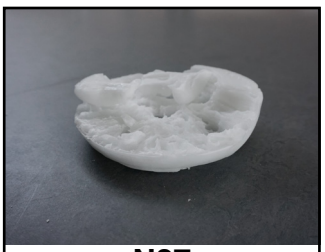

N19


N26


N6


N13


N20

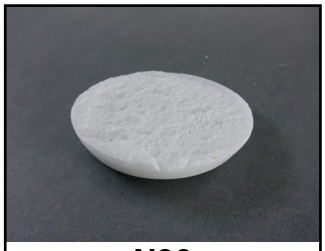

N27


N28

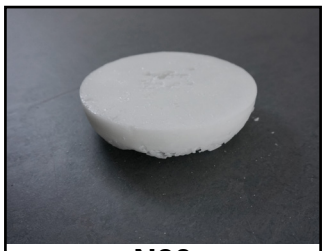

N35

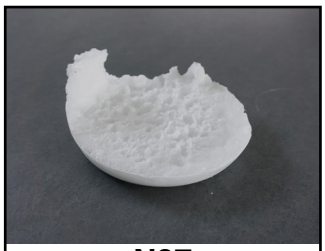

N42


N29

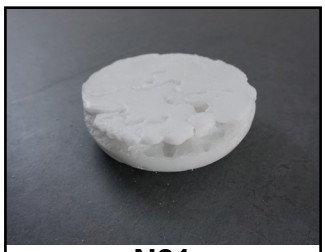

N36

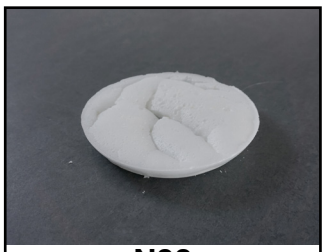

N43


N30

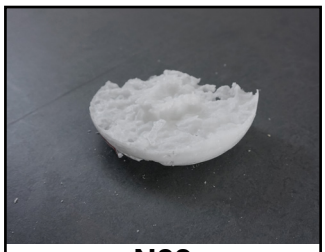

N37

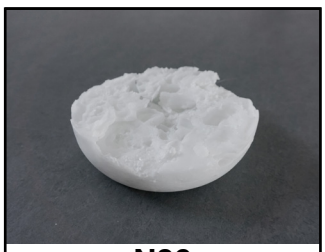

N44

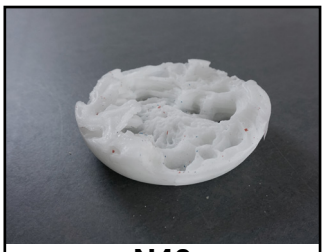

N31

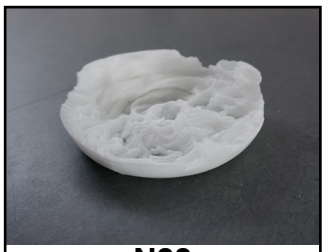

N38

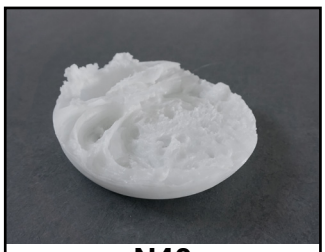

N45

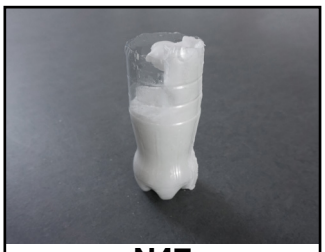

N32


N39

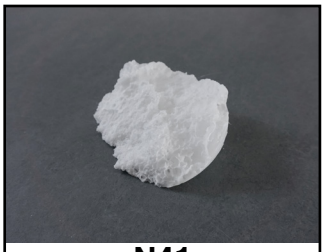

N46


N33


N40


N47


N34


N41


N48

By recording and summarizing all these experimental results, I found some rules in the reaction process between wax liquid and water, which will be published later.

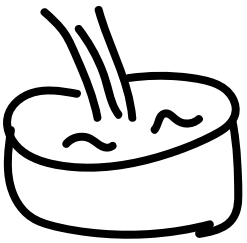
In short, in this experiment, I think the most important thing is that I have found some effective methods to artificially interfere with and control the final formed texture, which paves the way for more experiments in related fields in the future.

For example, in the future, if anyone is also interested in the reaction between wax liquid and water, I would suggest you do it in the condition of wax liquid (stearin) 70℃ together with water 25℃. It can lead to the bubble-shaped result, which I think is the ideal shape for casting.

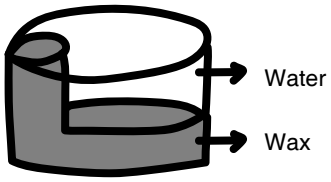
Core findings

Among my experiment results, I think two main findings are pretty representative.
First is the two-layer structure, whose upper layer is a bubble-like texture, and the lower layer is a messy, irregular texture.
The second is the one-layer structure whose texture could be controlled by how I pour water.

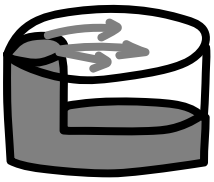
1 Two-layer structure



1. Pour water into hot wax liquid

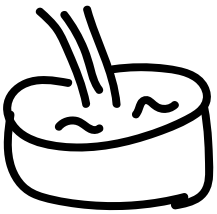


2. There is still some wax liquid that has not became solid, leaving a hole directly above

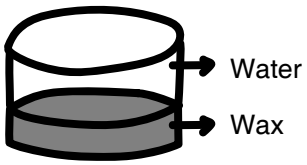


3. Hot wax liquid meet the cold water on the top layer, forming the bubble-like texture

2 One-layer structure



1. Pour super cold water into hot wax liquid



2. All the wax liquid become solid immediately

Does it have any value?

Application

In this part, I use several casting methods, trying to convert those wax molds I already had into other materials. So these patterns could have a broader application to other different kinds of products.

After I cast some patterns, I tried to find some applications for them. These applications are examples of the possibilities of these wax molds and the value of this material experiment.

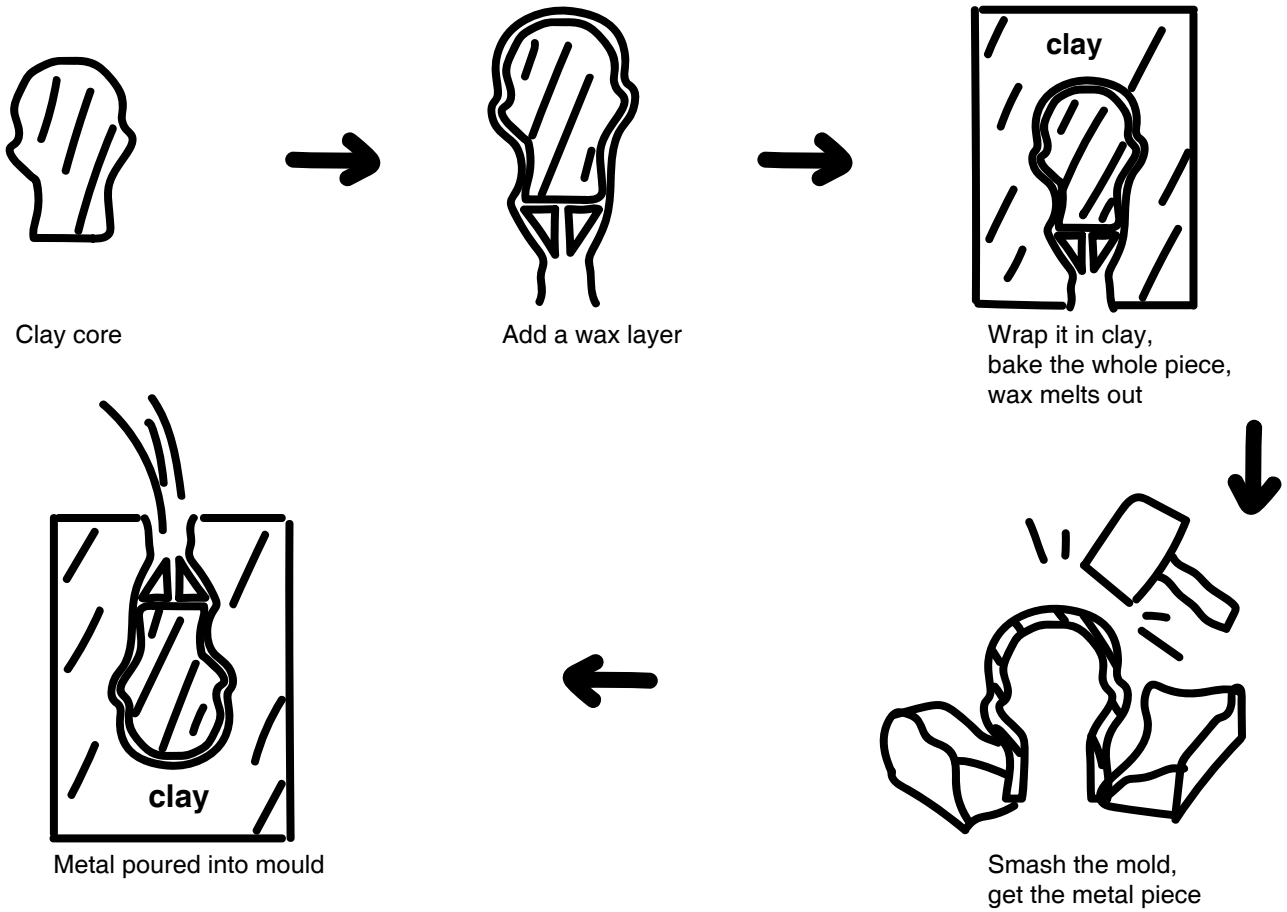
Research 2.0

In this research, I tried to find some way to convert my wax molds into other materials for a broader application in the future

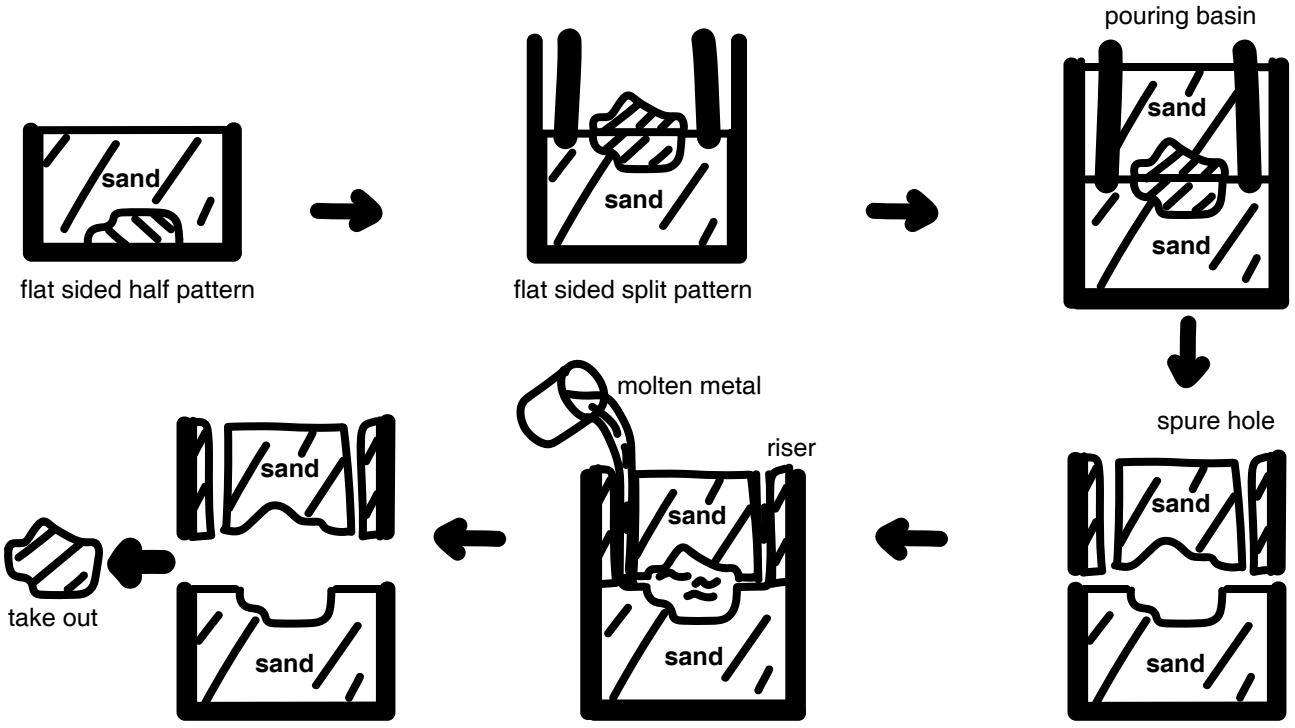
Casting method

- Lost wax casting method
- Sand casting method
- Slip casting method
- Silicon & Epoxy resin casting method

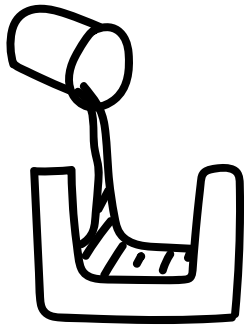
Lost wax casting



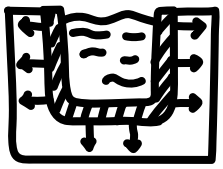
Sand casting



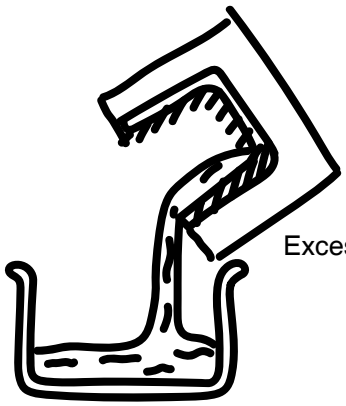
Slip casting



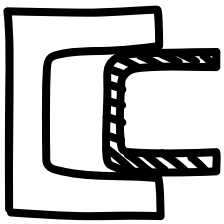
Fill mold with slip



Mold extracts liquid, forms compact along mold walls

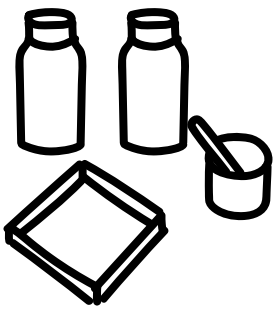


Excess slip drained

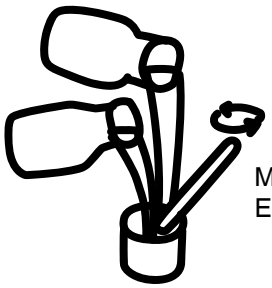


Casting removed after partial drying

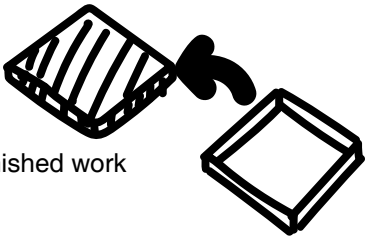
Silicon & Epoxy resin casting



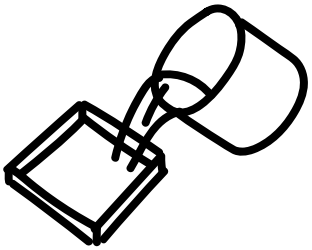
Prepare a mold, a stirrer and the silicon/ epoxy resin material



Mix Epoxy resin A and Epoxy resin B, keep stirring



Take out hte finished work



Pour the mixture into the mold

Execution

After the desktop research, I selected several feasible casting methods to try, and tested the effect on copying those patterns of wax molds

Three methods

- Sand casting
- Slip casting
- 3D scanning & CNC

Sand casting

Rosengren & Nilsson group AB is a company that focuses on sand casting.
It helped me sand cast my molds, converting wax to aluminum.
And I want to thank Sören Rosengren, who helped me a lot with sand casting.

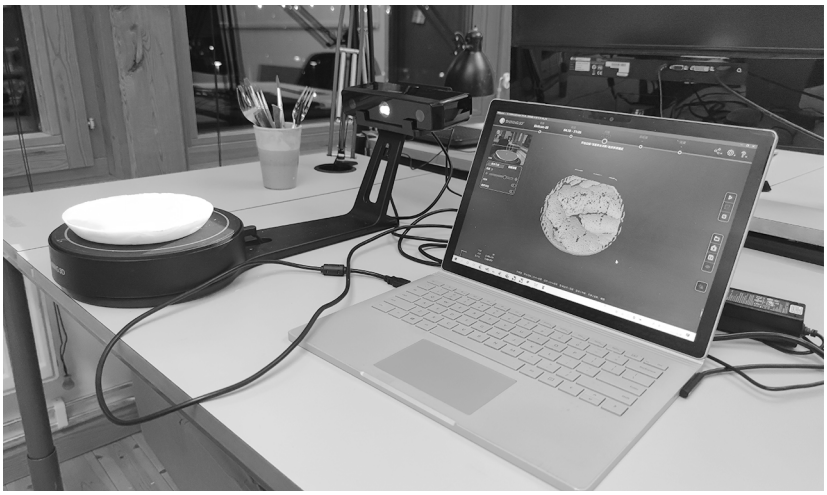
Slip casting

I tried slip casting at the ceramic worshop in IKDC. It was an exciting try, and I want to thank Wenjia Cheng(my classmate), she spent a lot of time teaching me how to make ceramic objects.

It turned out to be a failure because the structure I wanted to copy is so complex that I can't get it out from the plaster mold.

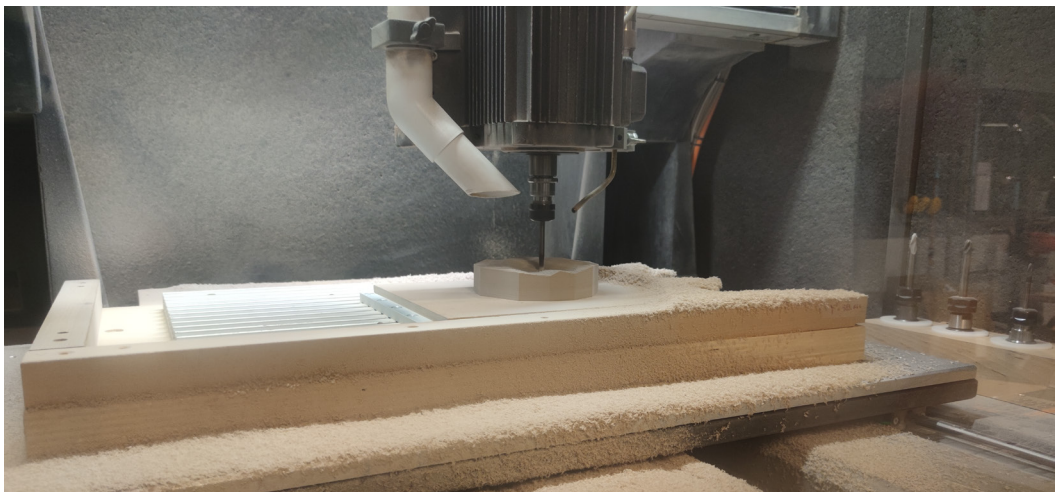
3D scanning & CNC

In this part, after I scanned my wax mold and got the 3D mold data, I simplified it in Rhino and got a simple shape. Then I converted it into a step file and sent that into a CNC machine to mill it



1. First, I scanned one of the patterns I picked by the 3D scanner and uploaded the 3D model to my computer.

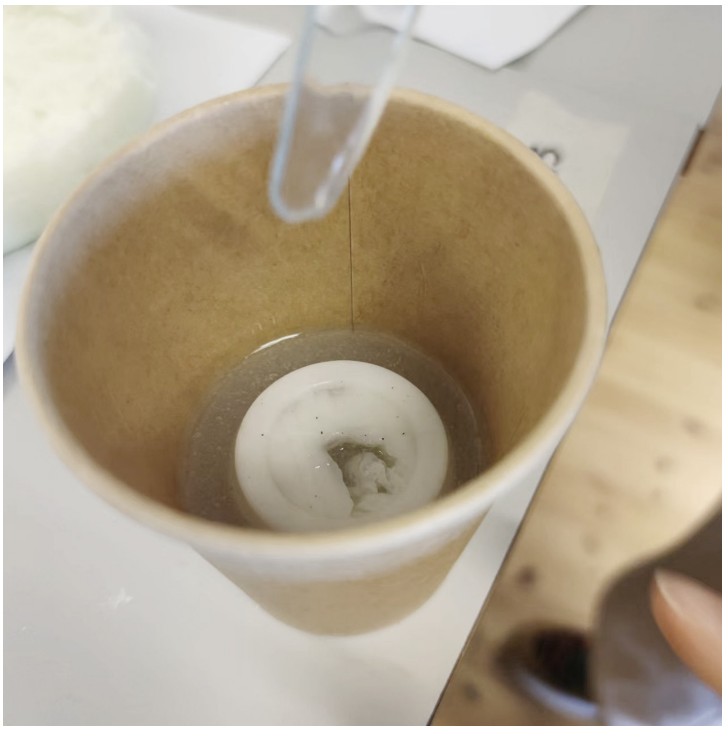
2. Then I simplified the 3D model in Rhino and exported it as a “step” file.



3.At last I sent the step file into a CNC machine to mill it in IKDC with the help of Josef.

Silicon & Epoxy resin casting

I also bought the silicon and epoxy resin on Amazon and made several tries on them.
Thanks to Yifan Jin, who helps me a lot with how to casting molds in silicone and epoxy resin.

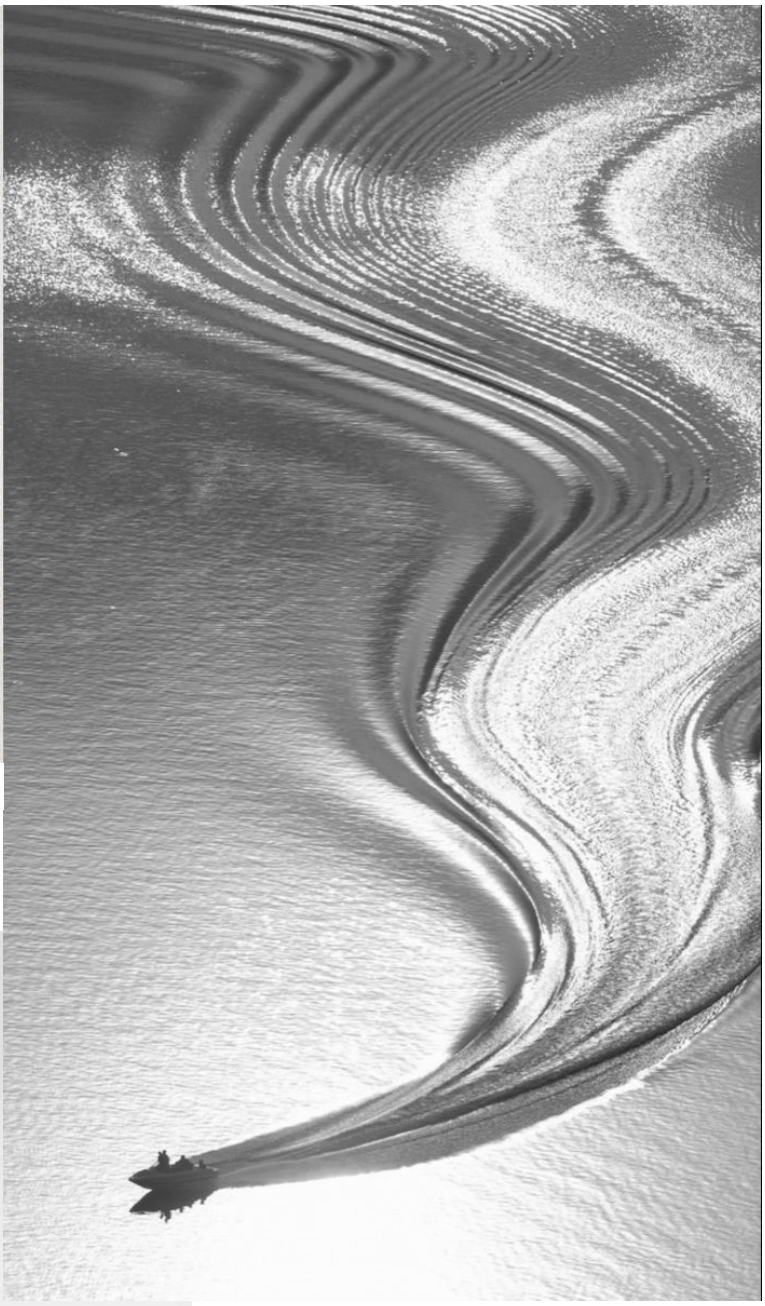


Final design

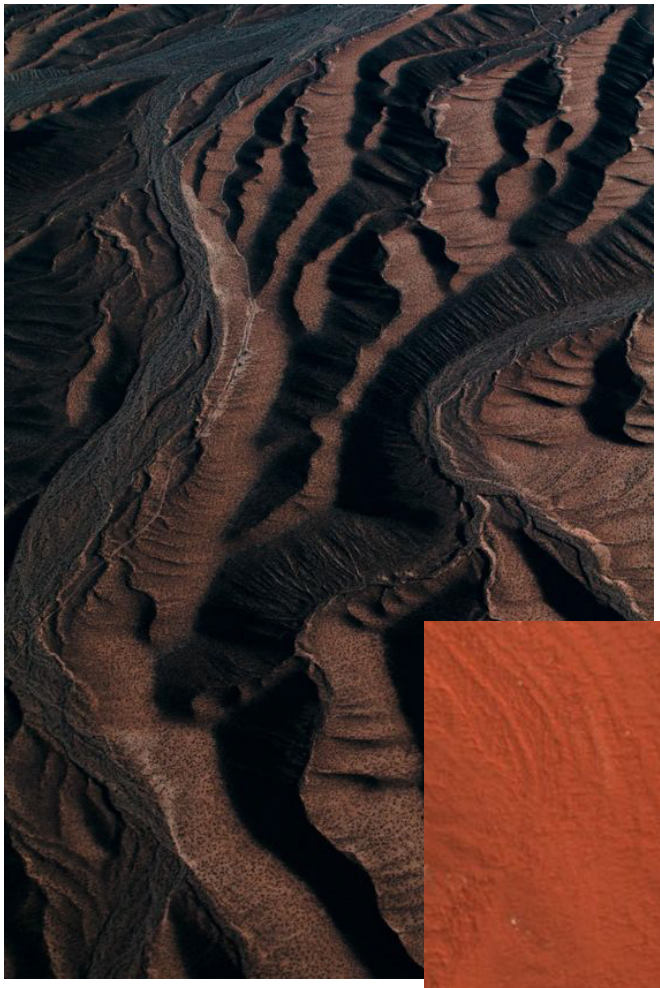
These applications are some examples to show the possibilities of these wax molds and the value of this material experiment.

There is still a massive space for improvement, and in my master thesis, I want to show as many possibilities as possible. Not focusing on making one specific product looks more pretty.

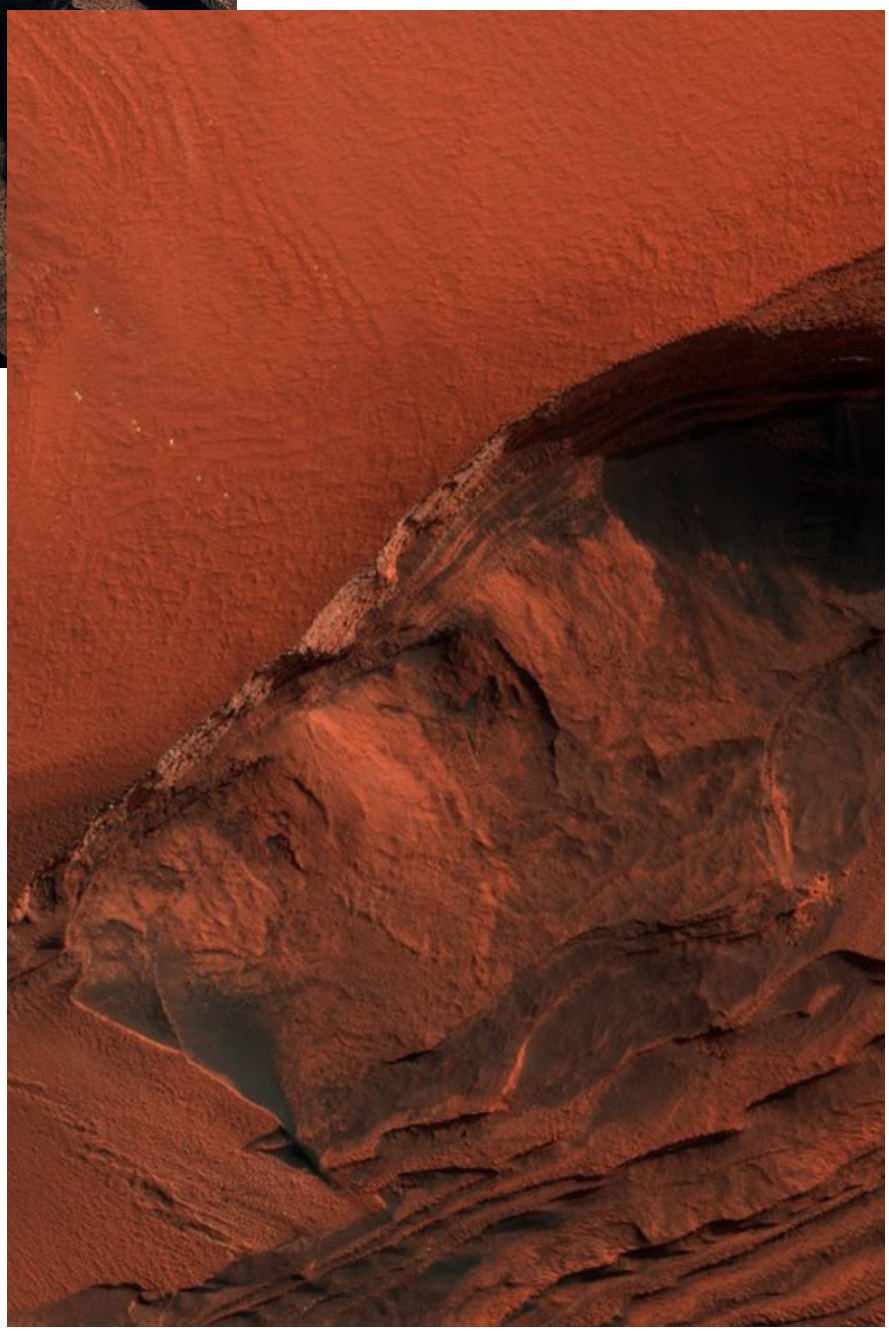
Inspiration



Highly contrasting



Rugged



Final design

It could be applied to **Candles**

It could be applied to **Necklaces**

In could be applied to
Plates

It could be applied to
Furnitures

It could be applied to
Electronic appliances

It could be applied to
Cups

Exhibition photos

What is the future development direction?

Business model

After I finished the previous work, I realized that there was an excellent business opportunity behind this wax-water material experiment.

First, since European love to use candles, there would be a considerable amount of wasted candles in churches, restaurants, and everyone's house, which means we can get the raw material at a super low price.

Second, each wax mold has its unique pattern, which can hardly be reproduced in another way except for wax liquid-water reaction. This ensures its unique value.

Last, after the previous experiment, I found some rules that govern it to form specific patterns. To some extent, it's under my control and predictable.

So I believe it has a huge potential to start a business based on this material experiment.

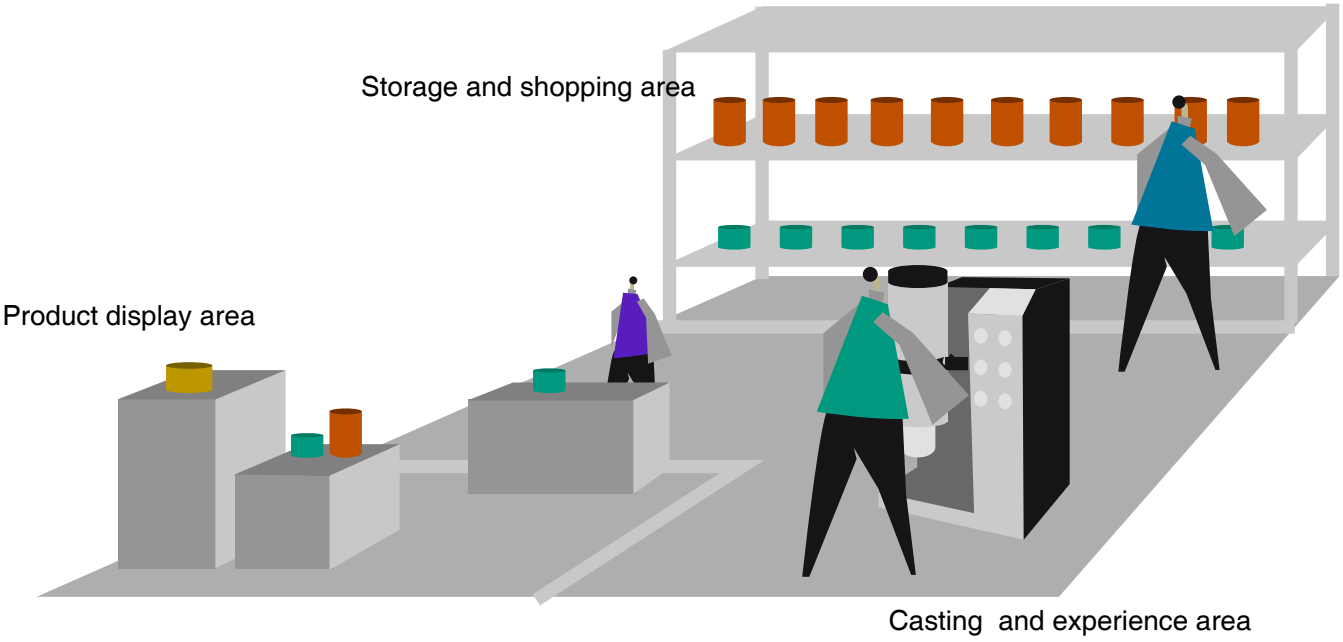
Benchmarking brand

Studio Arhoj

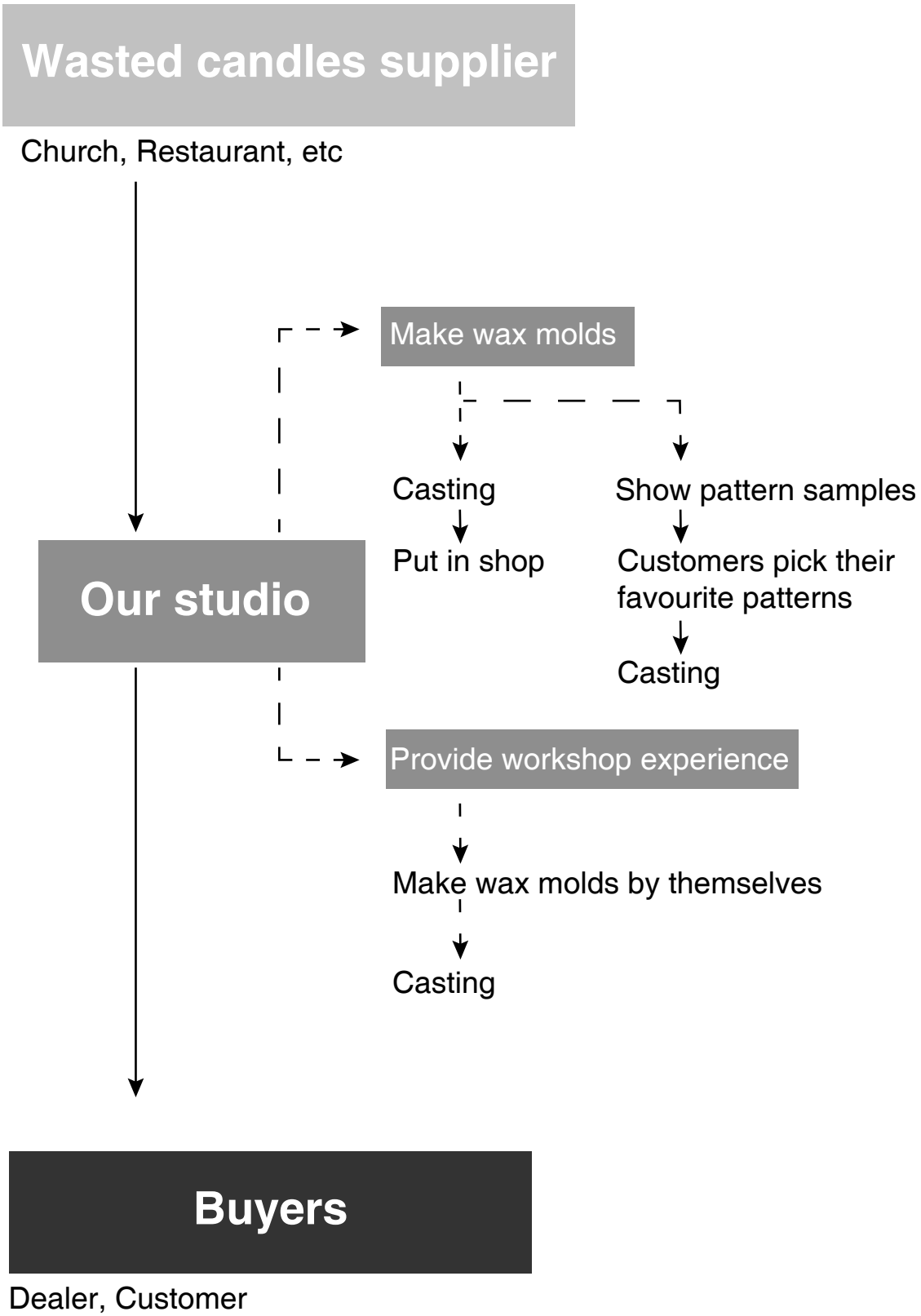
A studio which makes and sells hand thrown and hand cast ceramic items

A store integrating storage, workshop and selling

■ Management model



■ System map


Wasted candles supplier
Church, Restaurant, etc
Make wax molds
Casting
Put in shop
Show pattern samples
Customers pick their favourite patterns
Casting
Our studio
Provide workshop experience
Make wax molds by themselves
Casting
Buyers
Dealer, Customer

Reflection

My degree project is only a start. When I look back to this stuff which I've done in these months. There is still a vast space for me to improve. By summing up some experiences and lessons and putting forward ways to improve. I believe I can continue to optimize this experiment and make some valuable outputs in the future.

To be honest, some deficiencies still need to be improved when I review my output in the past few months now.

First, the tool I used in the experiment should be more accurate to produce more precise data. For example, because of the time limitation, I only poured the water manually, spending more time doing the process instead of making a more precise machine.

Second, it's a pity that I haven't tried the lost wax method. Theoretically, the lost wax casting method should be my project's most suitable molding method. However, since I failed to contact a local company that can provide this service, most of the final output is still based on sand casting, which is a pity.

Third, I only tried stearin in this project, but stearin is not the only stuff that belongs to the wax category. We also have paraffin, bee wax, and so on. And definitely, their characters would be different, which would make them act differently when they react to water.

Forth, 50 samples are still not enough for me to conclude the findings. I should do as much as possible in the future and find some of the best patterns and bring them into applications.

Lastly, most of my applications are not that detailed and polished. Since then, I have focused on providing as many possibilities as possible for my patterns and structures, so when it comes to the final product, they lose a lot of details. They have not been carefully handled, so the final output may look a little rough, which I want to improve in the future.

In summary, since this is a material experiment that started from a field I know nothing about, in this 6-month process, I paid a lot of time to find the next step and direction when I am still exploring. I went through the whole process from experiment to application as far as possible to have a broad understanding of this field. Suppose I have a chance to go deeper into this project. In that case, I will improve the above details and continue doing the wax liquid-water reaction experiment, which I firmly believe will be the core of my competitive advantage and business model.

THANKS FOR READING