Designing fire safe for corporate and commercial sector

Submitted in partial fulfilment of the requirements

of the degree of Master of Design

by

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INDIAN INSTITUTE OF TECHNOLOGY BOMBAY

(2018)

Approval Sheet

This dissertation entitled **"Designing fire safe for corporate and commercial sector"** by Sukanta Maharana is approved for partial fulfilment for the post graduate degree in Industrial Design

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Abstract

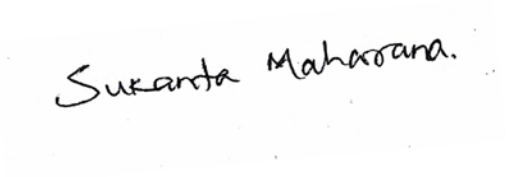
Safe is a rugged box made of unbreakable material where one can store documents and valuables. A fire safe additionally has the ability to save the documents and valuables from fire. Ever since man started colonizing and socializing they started storing things which are valuable to them. They made sure that their valuables are secure from every possible threat like climate, fire, theft, etc. Initially people used to hide valuables under some objects or up in the trees. Later they made wooden chests that became essential part of their culture. Metal braces are used on the wooden chest for additional strength. After fulfilment of their functional requirements they started anesthetizing the wooden chest with other decorative materials. By time people have advanced in metallurgy and used metal boxes for more safety. These boxes did evolve through many socioeconomic activities.

Many categories and subcategories came into the safe manufacturing based on its use, volume, placement and its functions. That can be broadly divided into **burglary safes** and **fire safes** based on their function. The fire safes protects the valuables from fire. As the modern lifestyle requires many legal documents, certificates, jewelry and some liquid cash, every household requires a fireproof safe. All the offices, both government and private, require fireproof safe.

My project comes under sponsored category. Proposal came from the MNC Gunnebo. Gunnebo India came up with this idea to manufacture fire safes for corporate offices and commercial sectors. Existing safes of Gunnibo has more generic design language. As the corporate sector has its own lifestyle, they need to come up with a safe design which suits corporate lifestyle. I took this project as it was a redesigning project and suits for my timeline of two and half months. Here my scope was to work on the form of the safe and interior. My limitations were to come up with a form which is almost a box which could be made by current production line, i cannot use big fillets,

Acknowledgement

Firstly, I would like to express my thanks and gratitude to my project guide Prof. Purba Joshi, without whom this project would not have been possible. I also would like to thank Mr. Ashutosh satpute(GM), Mr. Ketan raje, Mr. Ajay jadav, Mr. Mayur from Gunnebo for helping out with my project to understand the technicalities. Lastly, I would also like to specially thank that studio staff for helping me out with prototypes and my family and friends for being my support during project time.

Sukanta Maharana 

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Chapter 1

Introduction

As our social and financial status getting better the requirement of safety storage also increased. Increasing infrastructure of country also created more and more offices and banks which all handle cash and valuable documents. They all need a storage which protects the valuables from natural and artificial threats like fire and theft respectively. People resort to safes to fulfil these requirements. Depending on the customer and their use safe manufacturers build safes with different specifications. The size of the safe varies from a small box in a room to a room sized vault for banks.

Primitive safes were small wooden chests having a simple lock. Then people started using metal boxes which are safer in terms of strength. Industrial revolution opened up many options in materials and technology. Safe makers were consistently exploring the construction of the safe to protect from theft. Starting from the small wooden chest to multi layered, multi material, high tech lock safes, the construction technique changed exponentially. Simultaneously, safes also evolved as a luxury product in the rich society. In terms of luxury safes, not much exploration is done in terms of material and technology creating a huge market gap.

This project is sponsored by Gunnebo India. Gunnebo India are the manufacturers of security products like safes, fire extinguishers, entrance security for metro stations, etc. They intend to breach the market gap of safes with a range of fire safes targeting corporate customers. This gives them a bigger customer base above the existing market share. The intended safe range comes with sophisticated technology and better user interface. The intended safes also aims at other commercial offices and modern homes.

1.1 Design brief

Design a modern range of safes for corporate and commercial segment, respecting the brand identity of Gunnebo.

- Targeted customers are owners, managers, jewelers, shops, showrooms.
- Safe should have inner volume of ranging from 40lts to140lts with 4 to 5 sizes variations.
- Targeted elements for storage are documents, cash and jewelry.
- Safe will have biometric as well as key lock.
- Material used will be GI sheet of 0.8mm to 1.2mm thickness but other materials can be explored for better strength and aesthetics.
- For interior plastic or other polymers can be explored with security consideration.
- Safes shouldn't weigh more than 230kg for the highest size.
- Safes can be freestanding, floor/wall mounted or part of a furniture.
- Product ergonomics should be considered.
- The product will be branded as **Chubbsafes**.

1.2 Background

A safe is a secure space where money, valuables, records, and documents can be stored. Fire safes secure these valuables from a fire accident facilitating time to rescue. Safes protect their contents with armored walls and a tightly fashioned door closed with a lock. Safe technology evolved by time by arms race with robbers. As robbers come up with new ways to break the safe, safe makers found innovative ways to counter them. Modern safes are armed with a wide range of alarms and anti-theft technologies. Build quality of some nineteenth and early twentieth century vaults were so well that they are almost impossible to destroy even today. These older safes were typically made with thick steel walls. These safes were heavy as counted in tons. Now safe makers trying to get more strength sandwiching different materials to keep a check on total weight. Today safe makers have come up with wide range of safes in terms of technology, volume, material, social status etc. Almost all safes are rectangular boxes except some luxury safes like Dottling, Buben & Zorweg, Sentry safe, stockinger, Casoro jewellery safe, Boca do lobo, Agristi. The above companies are exploring in terms of material, form, mechanism in contrast with safes typically made with GI sheet with conventional door opening mechanism.

Figure 1.1 Existing market gap

1.3 Purpose

India is a fast growing country. Infrastructure is also growing at a rapid pace. Growth in commercial and corporate sector is happening which means more number of offices are coming up. All the offices handle very important documents, cash and other valuables. These offices need fire protection safes that are resistant to accidental fire. Modern homes also need fire safety safes. This is the good opportunity to widen the customer base for the Gunnebo India. They have the safes which are more generic and simple boxes. To cater the wide range of customer needs they should come up with more advanced and modern looking safes which suits modern customers. A huge market gap in the design of safes as well as in costing exists. So there is a huge scope of work involves in the domain of safes.

1.4 Delimitations

The project is limited to developing a form for the safe and the interior. It involves understand the corporate lifestyle and its attributes. The limitations were to come up with a form which is rectilinear, could be made by current production line. The use big fillets is not encouraged. The project has to be completed within academic timeline which involves two months of effective time. Other limitation is the user study, as this product deals with safety of customers secret and valuable subjects, people are not willing to talk on this subject. To come up with a feasible design, understanding the details of production line is important, which ideally takes one month of time. But due to time constrains, I could spend

only two days of time in site visit.

Chapter 2

Literature Survey

People needed security from the beginning of civilization. Locking system is the most essential for security. It's believed that the Egyptians made the earliest locks. Warded locks were used by Romans which were more sophisticated. Those locks were difficult to pick because of their special notches and grooves. Ancient Indians, Russians, and Chinese had their independent locking technologies. The combination lock is believed to be born in this part of world. The first versions of safes where built in medieval times, they were wooden chests reinforced with hammered iron bands. Originally, the reason was aesthetics. Till nineteenth century small iron boxes with lock were used in United States. After the Gold Rush in 1849, robbing increased. The robbers used to take the box out of the building to a lonely place and break them by hammer.

Safe makers came up with bigger and heavier metal boxes to cater the increasing demand of more safety but with the lock and key in the box robbers were still able to break it through the keyhole. In 1861, inventor ***Linus Yale Jr.*** introduced the combination lock. Safe makers quickly adopted the combination lock. Robbers also learned to break it. Some used force to punch the lock, others drilled the keyhole to see the slots of combination lock by a mirror. Robber also used to open the safe on gun point.

In 1818 ***Charles*** and ***Jeremiah Chubb*** patented the first secure lock mechanism known as Detector Lock. In 1835, Chubb patented a burglar-resistant safe and in the 1870s the time lock was invented after the inventions of the combination lock. ***James Sargent*** an employee of **Yale** developed the combination lock that worked on a timer. The safe door could only be opened after a set number of hours had passed, this helped to reduce robbing at gun point. Time locks became popular in banks and commercial sectors. Thieves developed tools to force open a tiny crack between the vault door and frame. As the crack widened, the thieves levered the door open or poured in gunpowder and blasted it off. Safe makers updated the door and frame with steps to counter levering which created the opportunity to open the safe by liquid ***nitroglycerin***. Professional bank robbers learned to boil dynamite in a kettle of water and skim the nitroglycerin off the top and dripped this volatile liquid into the door grooves to destroy the door. Safe makers eventually redesigned their doors so they closed with a thick, smooth, tapered plug. The plug fit so tightly that there was no room for the nitroglycerin.

By the 1920s, most banks avoided using safes and instead turned to gigantic, heavy vaults with walls and doors several feet thick. These vaults were still vulnerable to another new invention, the cutting torch. Burning oxygen and acetylene gas at about 3,315°C, the torch could easily cut through steel. It became popular with World War I. Robbers used cutting torches in over 200 bank robberies in 1924 alone. With the advance of metallurgy in the eighteenth century, safe makers got access to the technology required to build more secure safes. These were secure enough to frustrate attackers. Manufacturers learned to put a copper alloy into vault doors, when heated the copper alloy melted and became fluid. Immediately after removal of heat, the copper alloy solidified sealing the hole. This design improvement knocked down the robbers.

Technology and robbers race against each other. This resulted in invention of new devices such as heat sensors, motion detectors and alarms. Bank robbers developed even more technological tools to counter these systems. Although the number of bank robberies has been reduced but there are still attempts.

Materials used in safes evolved through time. The earlier safes had thick steel body and doors which could easily be cut by torches. Safe makers tried different materials. Cast iron showed more resistance to acetylene torches cutting. The modern safes have concrete in the wall and door covered with MS or GI sheet.

2.1 Types of safes

2.1.1 Types of safe based on core function

Safes are broadly classified into two types based on their core function such as **burglary safes** and **fire safes**. Burglary safes are mainly used to save valuables inside from theft. Here the construction technique mainly focuses on strength of the safe which should be difficult to break forcefully. Fire safes are mainly used to protect the valuables inside from fire. Here the construction technique is mainly focused on keeping cool inside the safe. Materials stored inside should not burn in a fire accident.

2.1.2 Types of safe based on general function

Many safes exist in market as per their general functions. These safes are used for a specific purposes in a specific scenario. They can be burglary safe, fire safe or both burglary and fire safe. These safes include home safes, mercantile safes, vaults, safe deposit boxes, night deposit safes, unconventional safes, etc.

Home safe:

Primarily intended for households. Since, ancient time’s people are using various forms of safes like wooden chests, metal boxes and now modern safes with high tech locking mechanisms. These safes have a distinct volume, look and feel. These safes generally vary from 40 liters to

100 liters, however people can always use bigger safes if needed. These safes are generally burglary safes but it should be both burglary and fire safe in the ideal case.

Mercantile safe:

Mercantile safes are generally both burglary and fire proof safes. These safes have much thicker walls and doors with a combination lock. Usually materials stored inside are fully insured by insurance companies.

Vaults:

A bigger version of burglary and fire safe, big enough as a room but some vaults can be bigger than that. The walls are made of high grade special RCC mix usually stronger than 30 M RCC having more tensile strength. This RCC requires maximum of 12 hours of curing. The wall contains mesh of special metal sections which resists from being drilled. The wall can be casted on site or precast walls can be assembled on site for faster construction. Vault door is generally made of same RCC cladded with steel.

Safe deposit boxes:

Made of thin (0.8 - 1.2 mm) sheet metal it’s a tiny metal box. Independently it's not so safe but it's a part of bank vaults or strong rooms. It is stored in the strong room of the banks and the strong room is pretty safe. This safe deposit box always have two keys as per the bank security system. One key is possessed by the customer and another by bank authority. Both the keys need to be used simultaneously to open the box.

Unconventional safes:

These safes come under high end or luxury products. Used by passionate people who have interest in specific products. This can be of many types depending on the products being stored such as gun safes, watch safes, etc. as these safes are owned by rich people the safe have different design language. It gives a opportunity to the safe makers to explore in material and technology and come up with exclusive products. There are some international companies who deals with these kind of products like Dottling, Buben & Zorweg, Sentry safe, stockinger, Casoro jewelry safe, Boca do lobo, Agristi, etc.

2.1.3 Types of safe based on their usability

Based on the usability aspect of the safes come as various types. It comes in all shapes and sizes looking at the ease and convenience of the user. These safes are Wall mounted safes, Floor mounted safes, Portable safe, Home safe, Office safe, Hotel safe, Drop safe, diversion safe.

Wall mounted safe:

This safe is basically a fire safe which can be fit on the wall. It gets flushed into the wall and gives a feeling of clear space. This can be a diversion safe also when it's covered by a photo frame.

Floor mounted safe:

This can be a fire safe or burglary safe stuck in the floor and the top surface is flushed with the floor. Here the user makes a niche in the floor of exact size of the safe and the safe goes into it. This also gives a feeling of clear space.

Portable safe:

These safes are tiny and made of thick steel sheets. These are single walled boxes. When user needs to carry some valuables and need safety these safes come into picture. These are lightweight and suitcase like products.

Home safe:

These safes are comparatively bigger than previous and generally burglary safes. It can also be a fire safe as per the user requirement. These safes are anchored also for extra safety. Earlier this was a product for rich people but now it is adopted by more and more people as they want their valuable documents to be safe. Earlier these safes were monochromatic but now it comes in various colors which will complement the home interior.

Wall mounted safe Floor mounted safe Portable safe Home safe

Figure 2.1 Types of safes 1

Office safe:

Almost similar to home safes but more formal in form and color. It essentially has minimum two keys possessed by two different member of the institution. These are heavy boxes placed on the floor sometimes anchored to floor also.

Hotel safe:

Small metal boxes with a key or biometric lock. These are used by hotels. They put these small metal boxes in the wardrobe of their hotel room. The guest staying at the hotel can keep the valuables in that for more security. These are lightweight and single walled boxes.

Drop safe

Safes having two essential parts such as dropping slot and storing box. Here user can drop cash or document through the slot which leads to the storage box. This safes are used by many organizations. This is unidirectional, but with some additional mechanism it can be bidirectional. ATM machine have these kind of safes.

Diversion safe:

This is a safe which portraits itself as another product. Its look and feel can be made like any other product other than the safe. It gives more safety as thief cannot find it easily.

Office safe

Hotel safe

Drop safe

Diversion safe

Figure 2.2 Types of safes 2

2.2 Basic anatomy of a safe

There are three basic components in a safe such as **the body, the door and the lock.**

2.2.1 The Body

This is the rugged box with single or multiple sides open to be closed by door. Initially it was made by thick wooden panels then replaced by thick metal plates. Now the body consists two boxes one is inner cell and other is outer cell made out of thin metal sheets. In between the two cells they put RCC to achieve desired strength. This body contains the door frame and hinge to attach the door. Safe body contains these basic components such as the rugged exterior, the door, the interior, infill, coffer, and the lighting

2.2.2 The Door

This is the strong panel which closes the access ways of the safe. This door is usually thicker than the wall of main body. This is also made out of steel sheet metal. This panel contains RCC inside and its cladded with the sheet metal. It has components such as the back pan, the spy shield, the hinge, the lock and the handle.

2.2.3 The Lock

The locks are most important component of the safe. Its design is very crucial to the whole safe design. If it's not safe enough then the strong and rugged safe body doesn't help. It's been influencing the safe design and status. With a complex lock the safe gets higher safety status. There are many types of locks based on physical key such as **warded lock, pin tumbler lock, wafer lock, disc tumbler lock and lever tumbler lock.** There are also many types of locks exist based on electric key system those are **key card lock, remote lock, keyboard lock, smart lock, sidebar lock.**

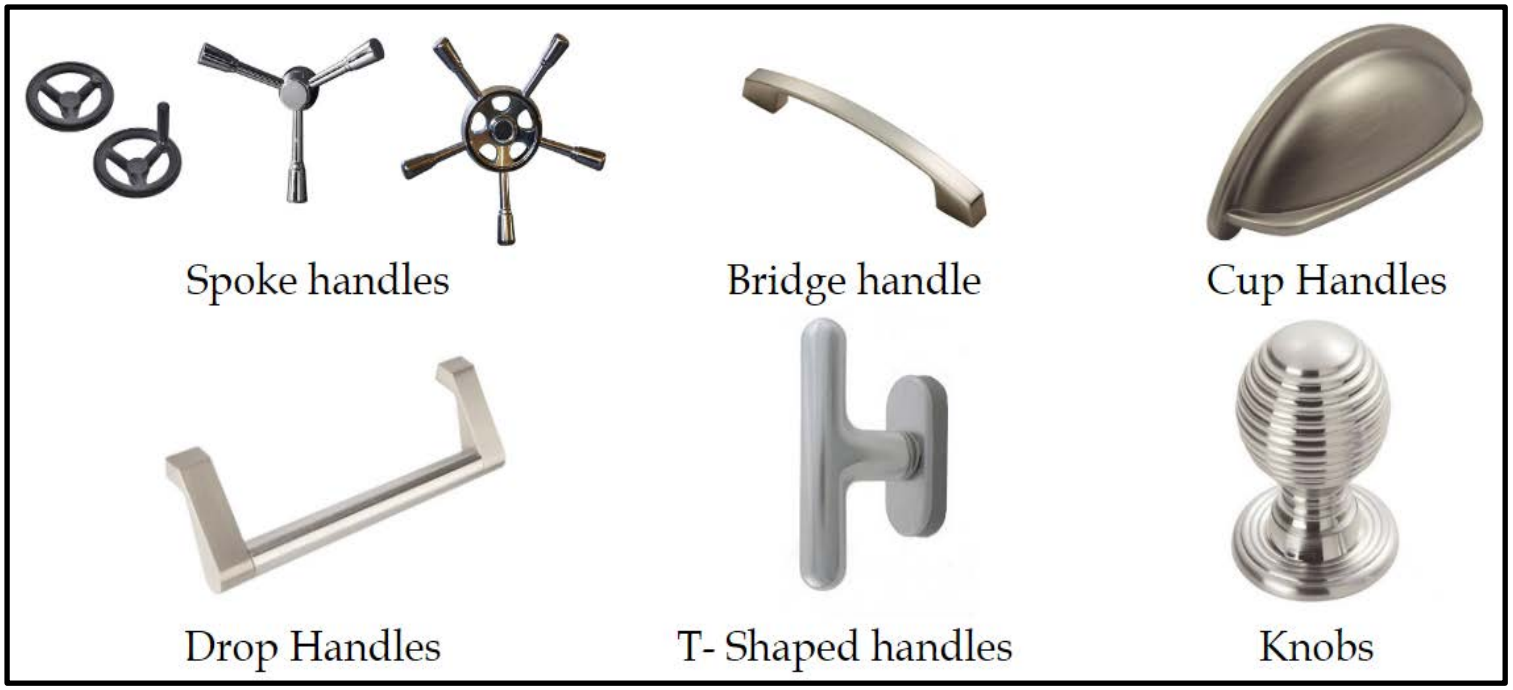

Figure 2.3 General types of handles exist in market

2.2.4 Good to have components

Looking at the modern lifestyle of users, there are some components which is good to have in a safe for the convenience of the user. These components serve as the value addition to the safe. These components are locking draw, Interior lighting, USB connectivity, carrying handle, digital media, soft interior, remote connectivity, inbuilt battery, handle for opening.

2.3 Attributes of a safe

There are some attributes based on which a safe should be designed. Ideal safe design should consider all these attributes. The attributes are explosion hardener, impact resistant, fireproof, water proof, tethering cable, pre resistance hinge bar, steel construction, anti-drill body, and anti-fish hopper.

2.3.1 Explosion hardener

Basic requirement of a safe because from the earlier time burglars first preferred technique is to put explosives in the hinge gap, door frame gap or in key hole and explode it. Construction technique of safe should not permit this type of scope. Safe manufacturers should take necessary measures to counter this.

2.3.2 Impact resistant

An old way to destroy a safe and get the valuables stored inside is by striking the joining's, hinges and the body. They try to deform the safe and open it. Here the safe should be so strong that it can take the impact of a hammer and not deform.

2.3.3 Fireproof

Sometimes fire accidents occur where all the materials gets burned and it gives a hard time to people. In this case if the most valuable documents and cash saved from this accident, people can survive this accidents. Here the safes can help people by its fire safety. Here the interior temperature doesn't rise with the fire. It gives a fair amount of time to rescue the valuables.

2.3.4 Waterproof

The safes should be waterproof and watertight to save the valuables in case of a flood or situation like that. If water gets into the safe the documents get wet and damage. The safe manufacturers should make sure that the safes are totally air and watertight when the door closed.

2.3.5 Tethering cable

The safes are often taken out of the premises by the thieves, especially if small in size. So there should be tethering cable or anchoring system for the small safes weighing less than one ton. It can be anchored to other static objects to achieve more safety.

2.3.6 Pry resistant hinge bar

The safes should have prey resistance hinge bar. Thieves also try to lever the hinge and door by placing levering rods in the small gaps in the hinge and the door. Doors should fit tight in the frame and it should leave no space when closed. Hinge should be covered or hidden in the body.

2.3.7 Steel construction

Construction techniques and the mechanisms used in the safe manufacture should be robust and should not show any sign of weakness. The design language of the safe should reflect ruggedness giving a strong look & feel.

2.3.8 Anti drill body

A common technique of theft is to drill and cut or drill and explode the safe. The manufacturer should implement anti drill techniques.

2.3.9 Anti fish hopper

Thieves put hooks in the door gaps of the safe to pull out the valuables stored inside or to damage the valuables. It can be avoided by implementing multiple precautions in the door frame constructions.

2.4 Existing products of Gunnebo

Gunnebo India manufactures a range of safes with various volumes. Safes come under two brandings such as **Steelage** and **Chubbsafe**.

2.4.1 Steelage

Basically burglary resistant safes, heavier than Chubbsafes as they put concrete (M30 or more) in the walls of safe which are made of mild steel sheet metal. Uses minimum of 0.8mm thick MS sheet to make the body. This gives a really tough body. They put specially designed sections as reinforcement in the wall which protects the safe from drilling. These sections create surfaces which are adverse for drilling. This safes are painted dark gray.

Figure 2.4 Metal sections used in the wall of safes

Figure 2.5 Steelage safes from Gunnebo

Burglary resistant safes are graded based on two parameters such as time taken to make a hole of specified diameter on the safe and resistance points. The tool used in cutting has points called resistance points. Bigger the tool has more points. The time taken to cut the hole multiplied by resistance points to get final point. Bigger final point means better safe. Based on this technique they have four grades of burglary safes. **BB class** (15 minutes), **A class** (30 minutes), **AA class** (60 minutes) and **AAA class** (90 minutes).

2.4.2 Chubbsafe

Chubbsafes are basically fire resistant safes. These safes are lighter than Steelage as they use foam concrete here in the walls. These safes give some burglary resistance but mainly protects valuables from fire. Here they use 0.8mm - 1.2mm thick galvanized iron sheet metal to make the body and door then pour foam concrete into it.

Figure 2.6 - Chubbsafes from Gunnebo

Paper starts getting black at a temperature of 177° C, hence the temperature inside safe should not rise than 177° C. The rating of fire resistant safes depend on this factor. There are 1-15 grades exist for fire safe but Gunnebo India makes safes graded up to 4. This grades are

dependent on the time slab. The time slab for the grading are 30 minutes(grade 1), 60 minutes(grade 2), 90 minutes(grade 3) and 120 minutes(grade 4).There are two types of tests conducted on the fire safes to check the grade of the safe. Those tests are **fire resistance test** and f**ire impact test.**

Fire resistance test

As the ideal temperature of a burning house is around 700° C they put the safe in a fire of 1000° C for the time duration of claimed grade. Papers are placed inside the safe before the fire is set. Technically when the outer temperature of the safe is 1000° C, the interior temperature of the safe shouldn't raise more than 177° C.

Fire impact test

The safe is exposed to 1000° C fire for the claimed time and then they drop it from 3 meter height as per BIS standard, 10 meter as per EN standard. This process is to mimic the possibility of building collapsing in fire accident. After drop they check interior temperature of the safe which should not exceed 177° C.

This temperature control ability of the fire safes based on the simple logic of evaporation. To understand the technique of this fire safes we need to understand the construction procedure. They put foam concrete inside the cavity walls of safe which is basically diatomaceous earth mixed with foaming chemical. This diatomaceous earth has 2.7gm/cc density, which reduces to 0.9gm/cc density when mixed with foaming chemical. That's how fire safes are lighter than burglary safes. After pouring foam concrete into the cavity wall they seal the opening. Water gets trapped in the pores of the foam concrete. They have small holes on each face of the safe closed with plastic plugs. They also put insulating sealing washer on the edge of door. This sealing material expands five times and seals the door gap making it air tight. In case of fire, resistance comes from foam concrete. It acts as insulating wall. The temperature inside starts raising. Then the water trapped inside starts boiling at 100° C. then the temperature stops rising inside the safe as all the heat absorbed by water. The water becomes vapor comes out of the wall through the hole on wall as sealing plug melts in fire. Vapor takes the heat out of safe and keeps it cool. This process continues till all water gets evaporated from wall of the safe. After that interior temperature slowly increases. This process gives enough time to rescue it.

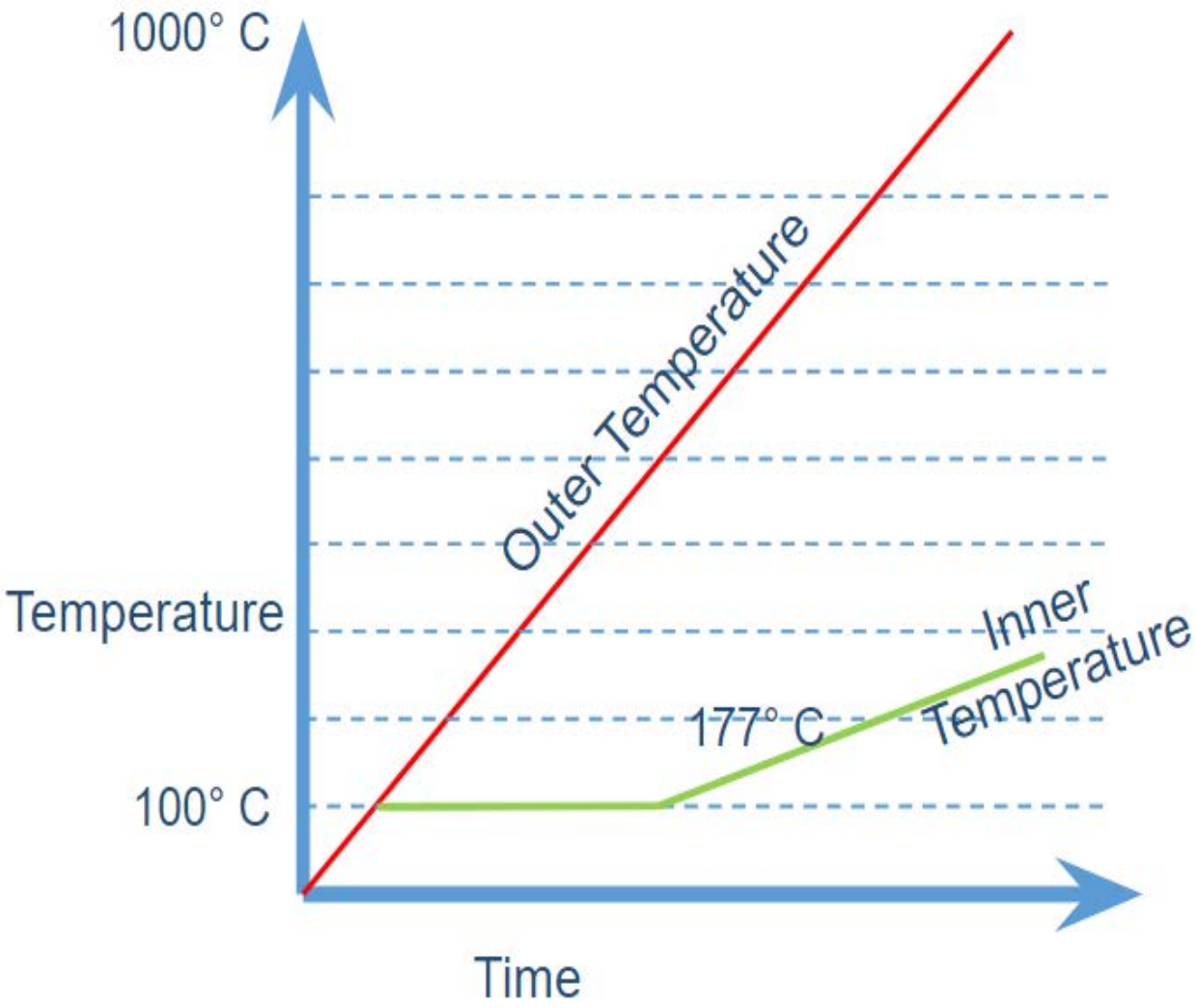

Figure 2.7 Graph showing rise in temperature in a fire safe in fire accident

2.5 Parallel Products

Many companies compete nationally and internationally who manufacture safes. International manufacturer are Fire security safe co, Sentry safe, Gardex, Rosengrens, etc and national manufacturer include Godrej, Teknokrats, Dhanlaxmi safe company, Safe engineers, Safe and safe, etc. Godrej is the most prominent player in the domestic safe market.

Figure 2.8 Safes of Godrej

Figure 2.9 Parallel products in international market

2.6 Site visit

Gunnebo India has a manufacturing plant in Halol near Vadodra in the panchmahal district of Gujrat. I visited the plant for two days. I went through both fire safe and burglary safe assembly line thoroughly. I tried to get as much as information and understand the assembly line.

Observed the technical details of the safe making start to end assembly. This assembly line starts with the bigger sheet metals. They follow these process step by step as **Punching/ laser cutting, Sheet bending, Welding, Sealing the joint, Inner and outer box assembly, Concrete filling, Curing (8-12 hrs), Paint shop, Drying, Quality check, Component assembly, packaging**.

Figure 2.10 Pictures of fire resistant safe taken in the plant assembly line showing internal details.

Figure 2.11 Pictures of burglary resistant safe, taken in the plant assembly line showing internal details

2.7 User Study

- People prefer physical key lock as there is a chance of forgetting the password.
- They put small safes in the vault.
- They prefer to have a handle to open the door.
- The safe should merge in the background.
- They do not experiment on buying safes.
- Bigger the bolt size, the better the product.
- Weight is not a problem as they do not move the safe.
- Multi user safe is more preferred.
- The cost is affordable for now.

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Chapter 3

Designing the fire safe

3.1 Brand value

There are many attributes considered by the company which creates the brand value and desirability for that brand in the customers. The attributes are as follows

- Consumer feel(*approachable, modern, fresh)*
- Iconic(*exemplary, disruptive, innovative)*
- Intuitive (*integrated, ease of use, simple*)
- High quality (*premium, high value)*
- Form/ Function *(efficient, obvious)*
- Trustworthy (*reliable, accurate)*

3.2 Brand identity

All corporations and organizations always want to have some signature character which is exclusively seen in the organization. Customers always identify the company by those elements. Sometimes customers start building their story around if they like the brand. Gunnebo also has some brand identity elements in their products such as three armed handle, straight edges in the body, logo, the color, etc. these elements will be my most essential tool for designing the safe for Gunnebo India. These elements must be implemented to retain the brand integrity.

Figure 3.1 Brand identity elements of Gunnebo India.

3.3 Mood board

3.3.1 Modern

Figure 3.2 Mood board for the attribute Modern

Keywords - Clean, Unibody, Light, Contrast, Sleek, Technology.

3.3.2 Minimalistic

Figure 3.3 Mood board for the attribute Minimalistic

Keywords - simple, moderate, practical, clean, essential, lowkey, basic, functional, silent, futuristic.

3.3.3 Futuristic

Figure 3.4 Mood board for the attribute Futuristic

Keywords - Trend setter, miniature, Sci fi, iconic, noble, fluid, clean, and minimal.

3.3.4 Rugged

Figure 3.5 - Mood board for the attribute Rugged

Keywords - Heavy, Tough, Ribbed, Uneven, Imposing, Subtle.

3.3.5 Handles

Figure 3.6 Mood board for the design language of handles

Keywords - Minimal, simple, smooth, clean. High tech, sleek.

3.4 Different ways of opening a safe

3.4.1 Moving core

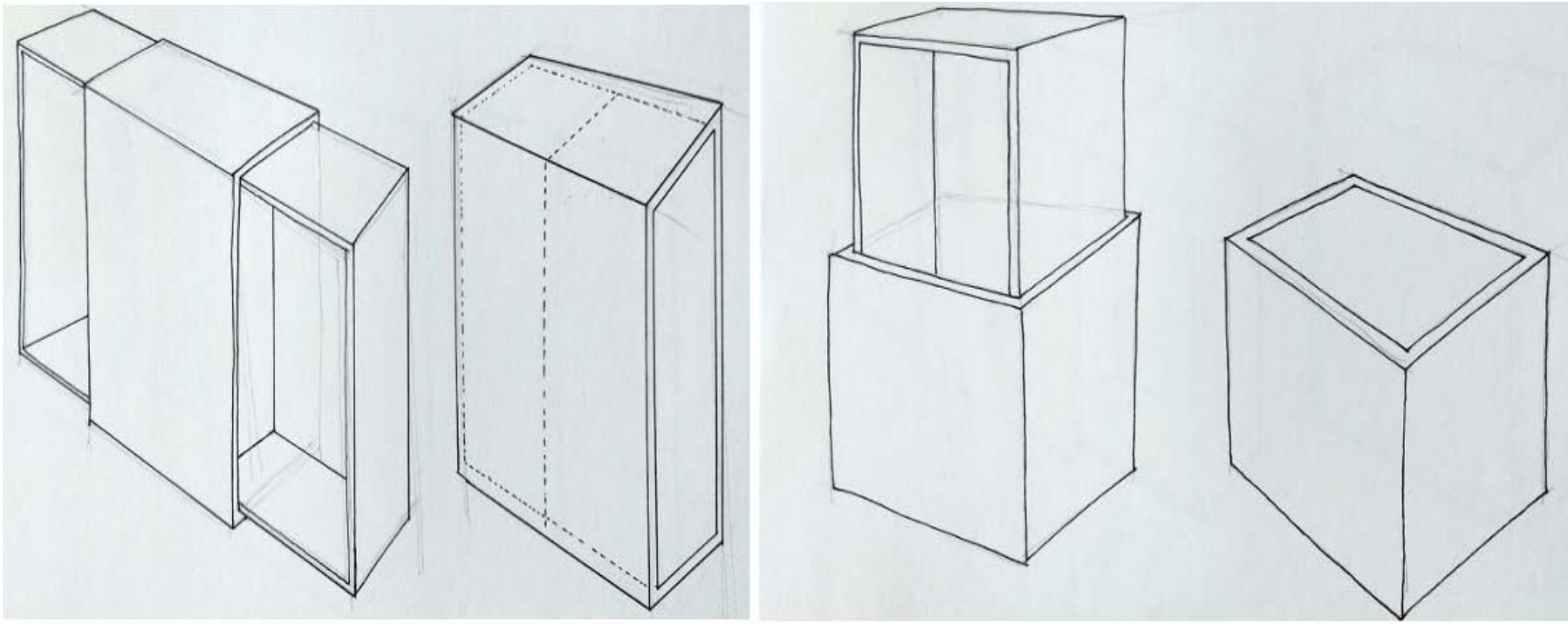

Figure 3.7 Sketch showing unconventional ways of opening a safe.

3.4.2 Moving sell

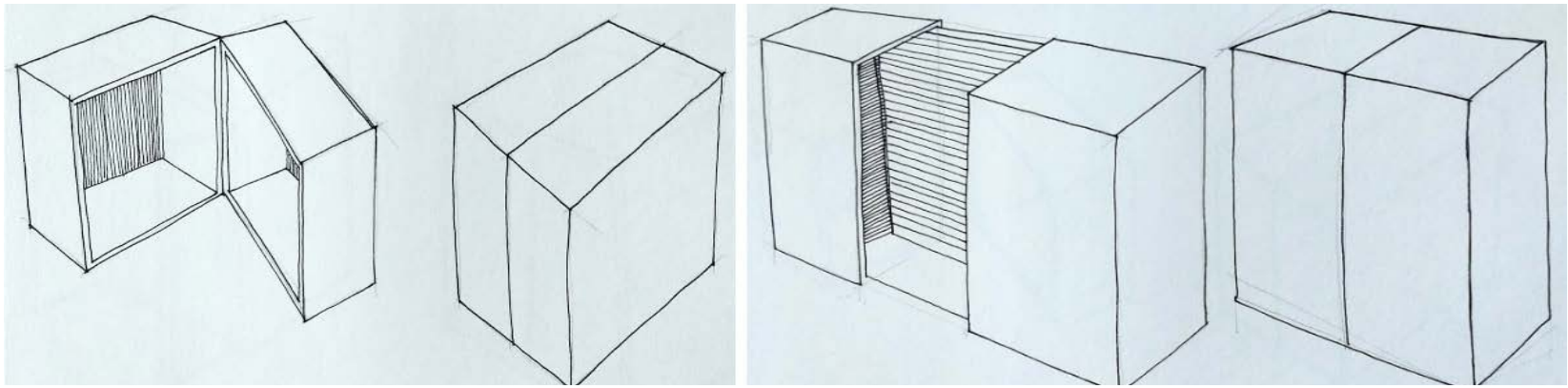

Figure 3.8 Sketch showing unconventional ways of opening a safe.

3.4.3 Multiple openings

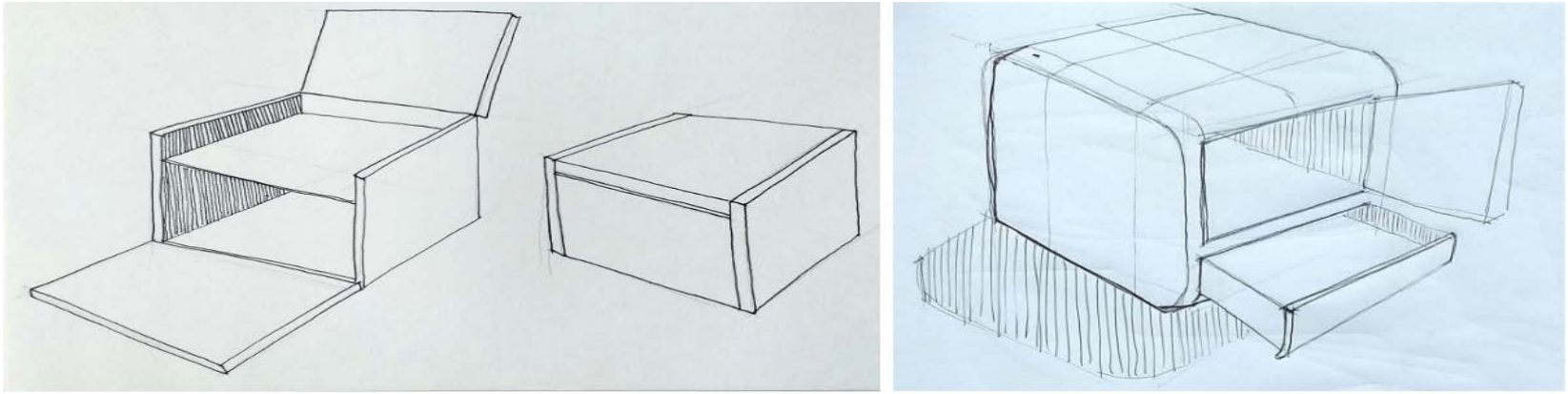

Figure 3.9 Sketch showing multiple ways of opening a safe simultaneously.

3.4.4 Conventional openings

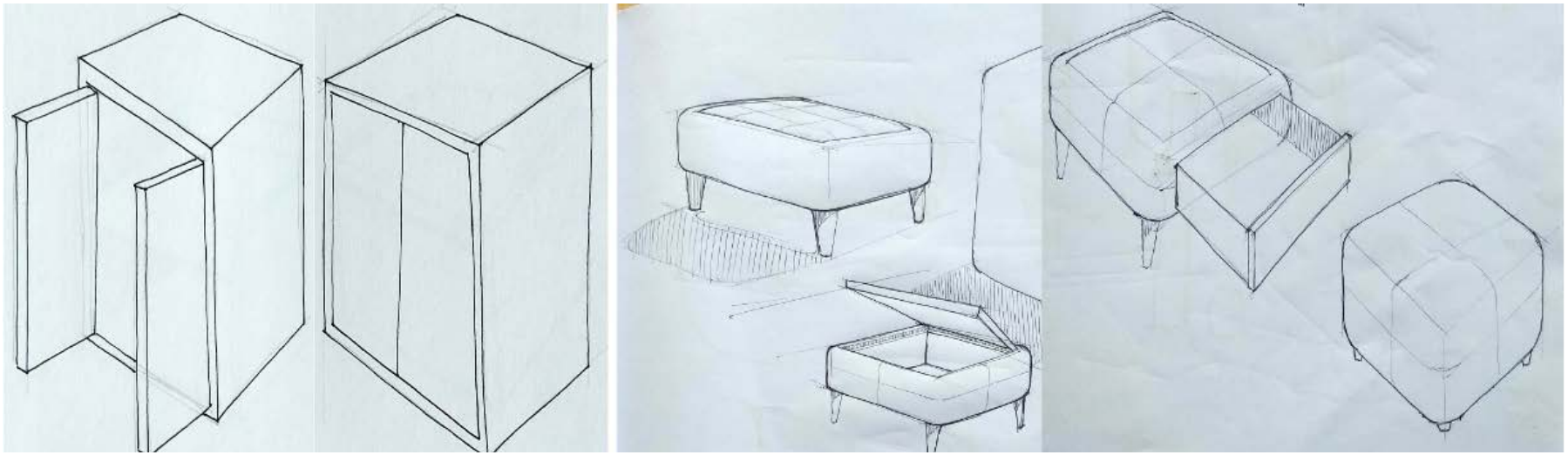

Figure 3.10 Sketch showing conventional ways of opening a safe

3.5 Ideation

3.5.1 Ideation 01

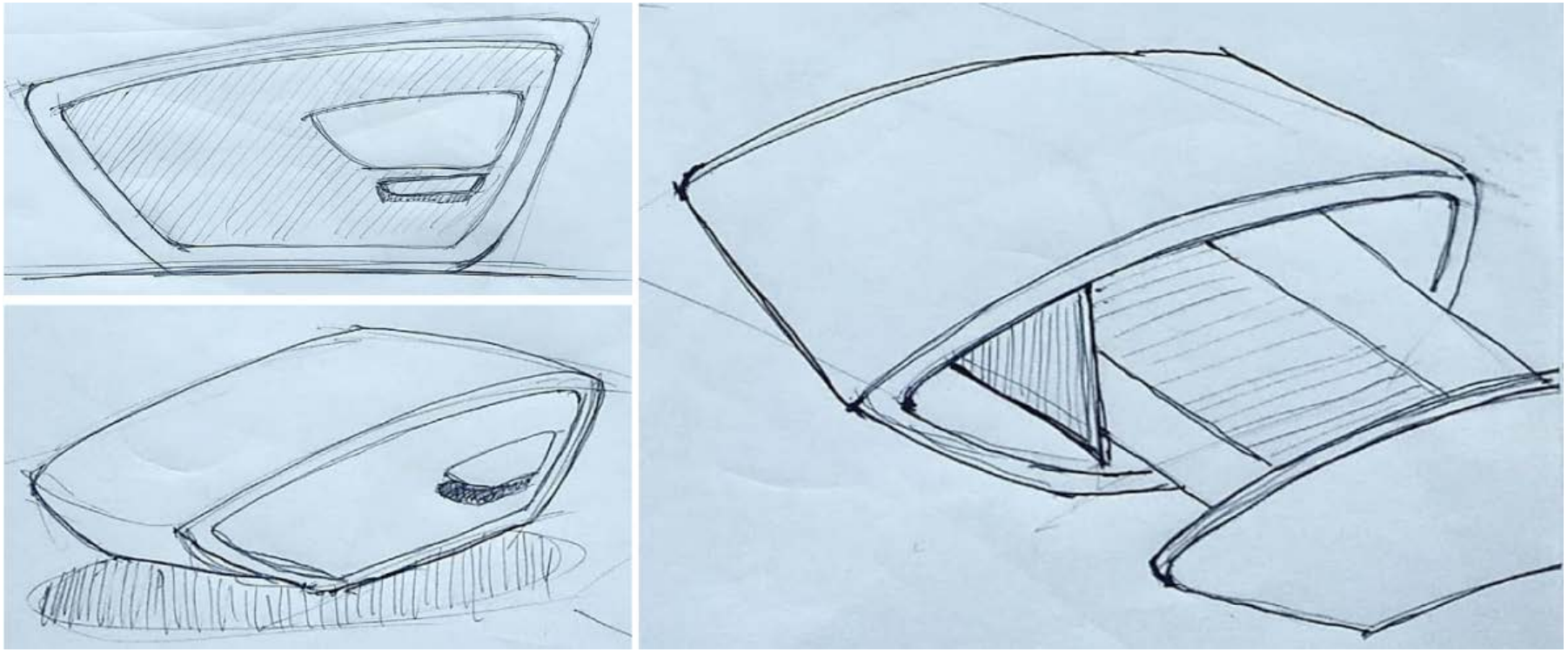

Figure 3.11 Ideation sketch one

Keywords - Organic, Generous radius, Approachable, Modern, Unconventional

3.5.2 Ideation 02

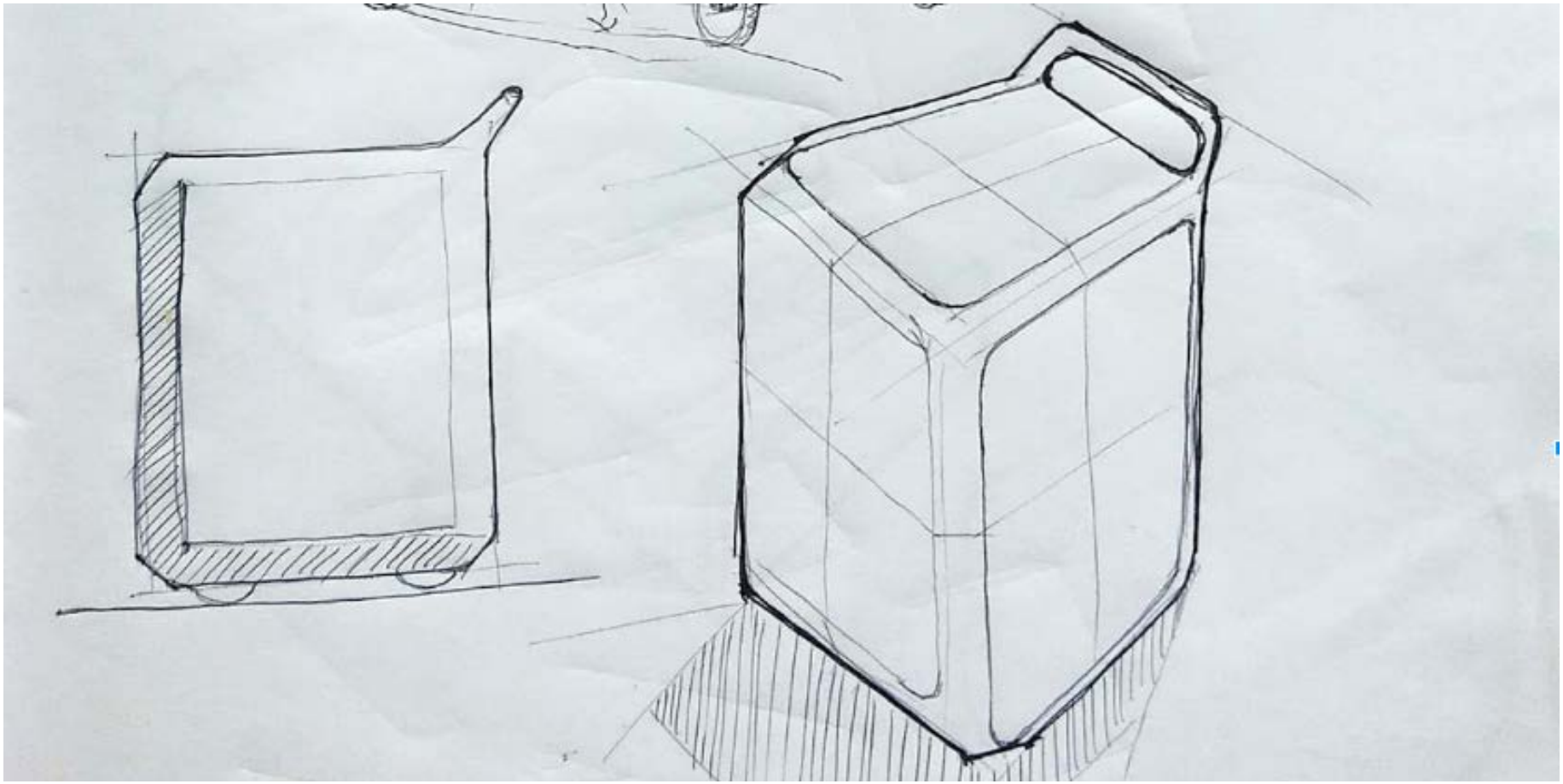

Figure 3.12 Ideation sketch two

Keyword -Straight lines, Tight Radius, Large chamfers, Rigid, Stable, confident,

3.5.3 Ideation 03

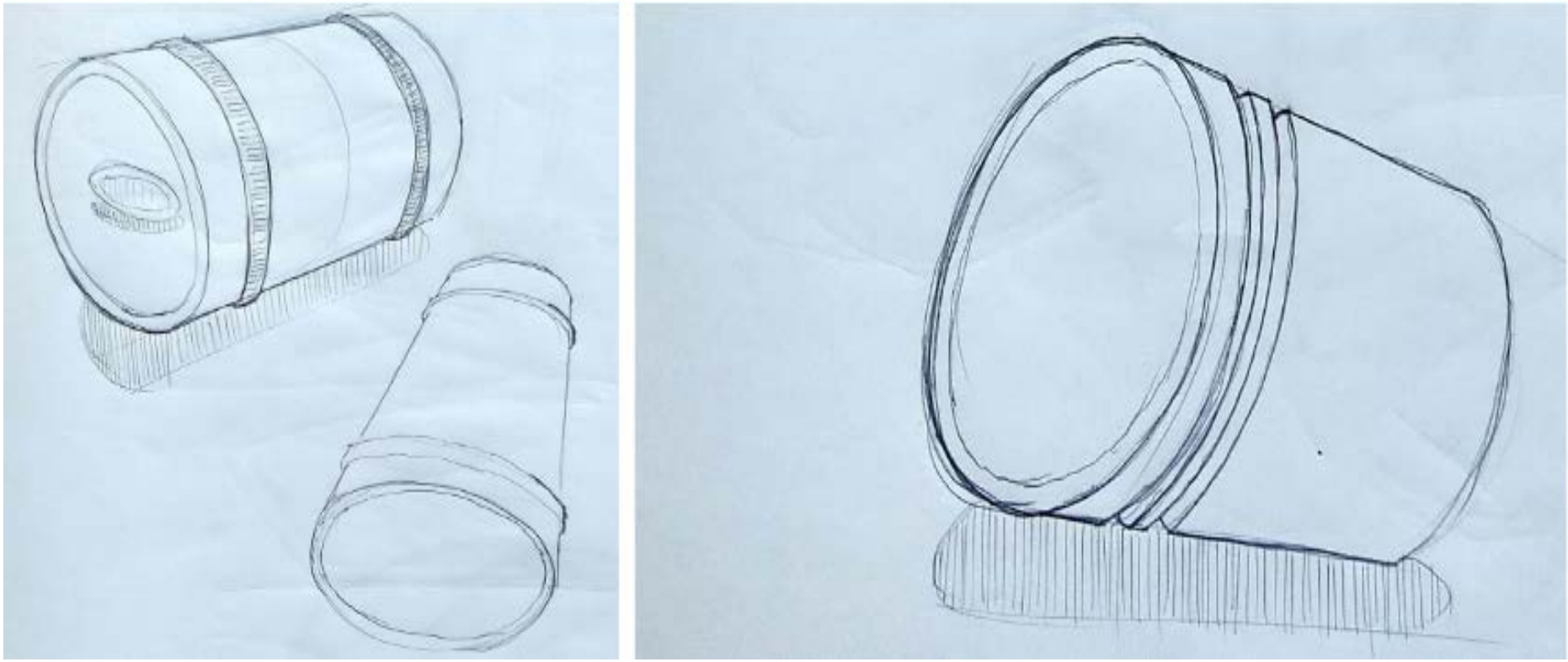

Figure 3.13 Ideation sketch three

Keywords - Rounded, Mobile, Unconventional, Rubber grip band, minimal,

3.5.4 Ideation 04

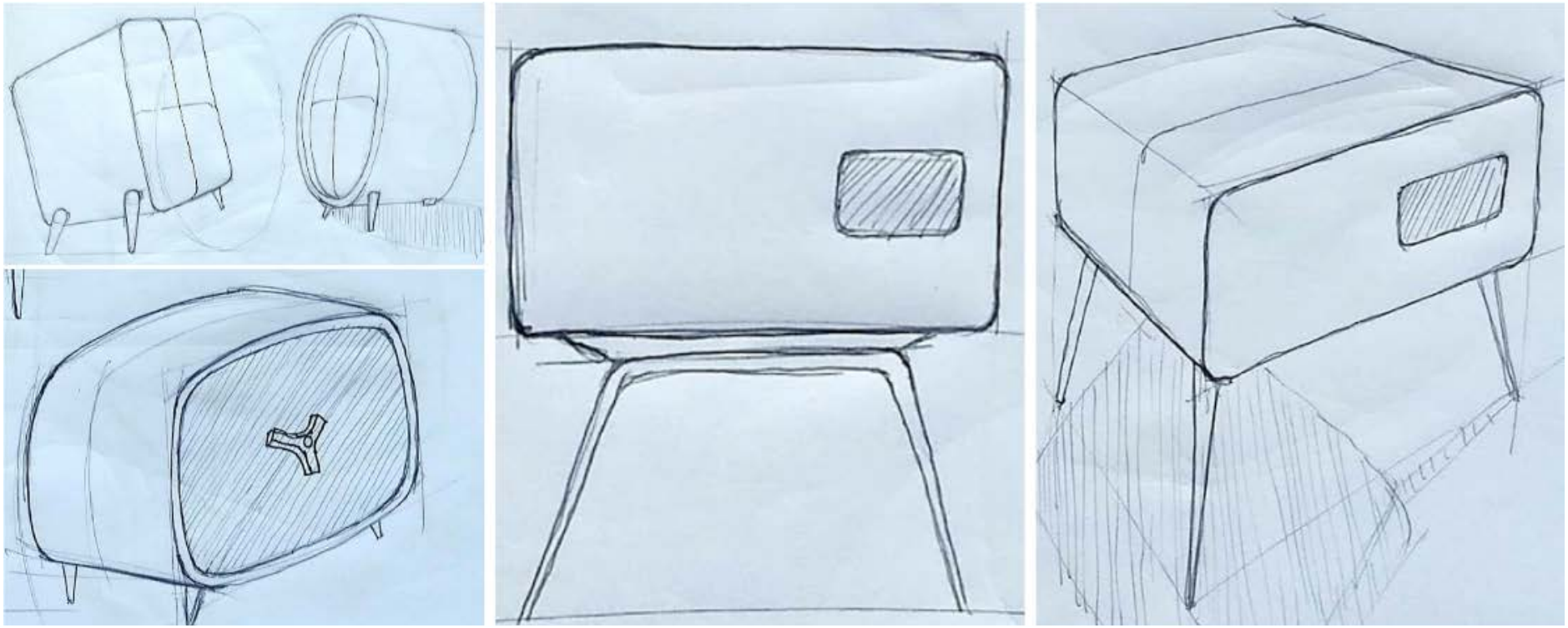

Figure 3.14 Ideation sketch four

Keywords - Usability, Clearance, Retro, Elevated, Large radius, minimal,

3.5.5 Ideation 05

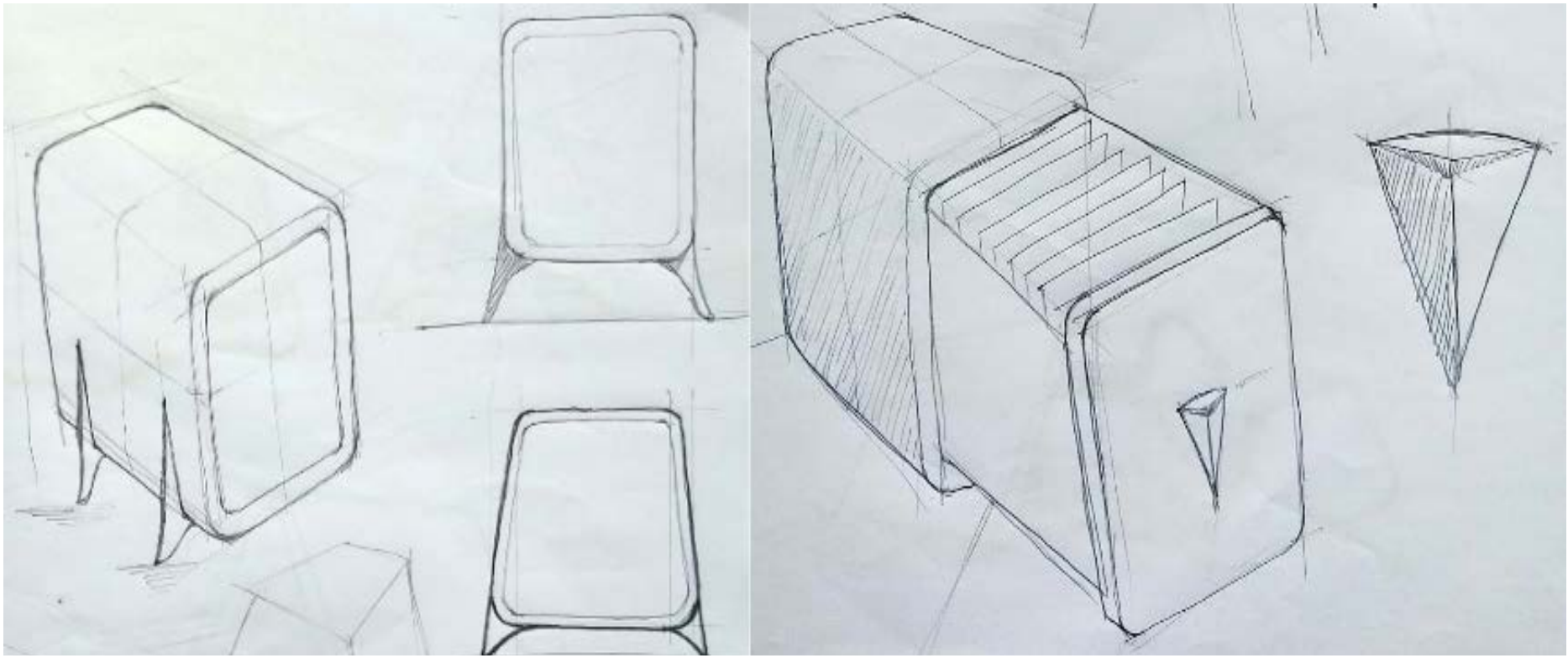

Figure 3.15 Ideation sketch five

Keywords - Stable, Concentric, Tapered, Round edge, Flush handle

3.5.6 Ideation 06

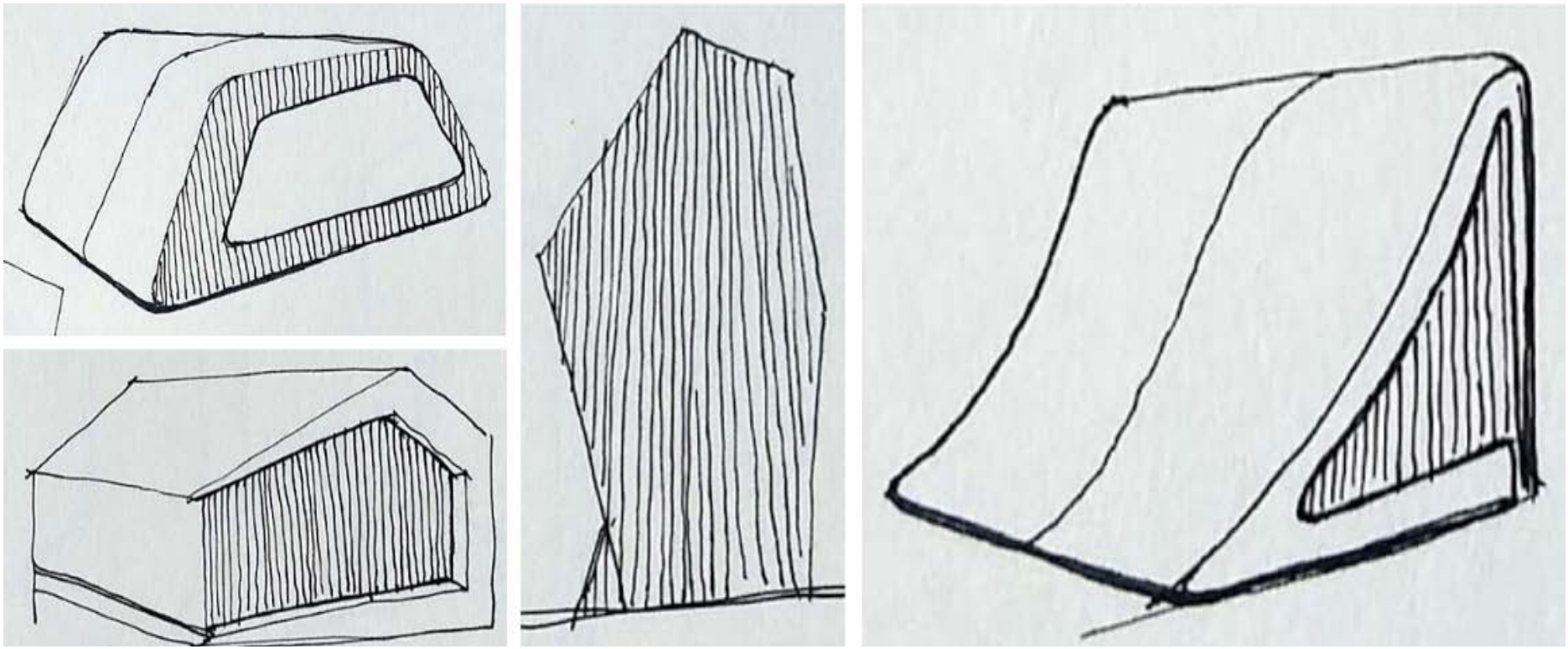

Figure 3.16 Ideation sketch six

Keywords - Free forms, Radical, Extruded, iconic, futuristic

3.5.7 Ideation 07

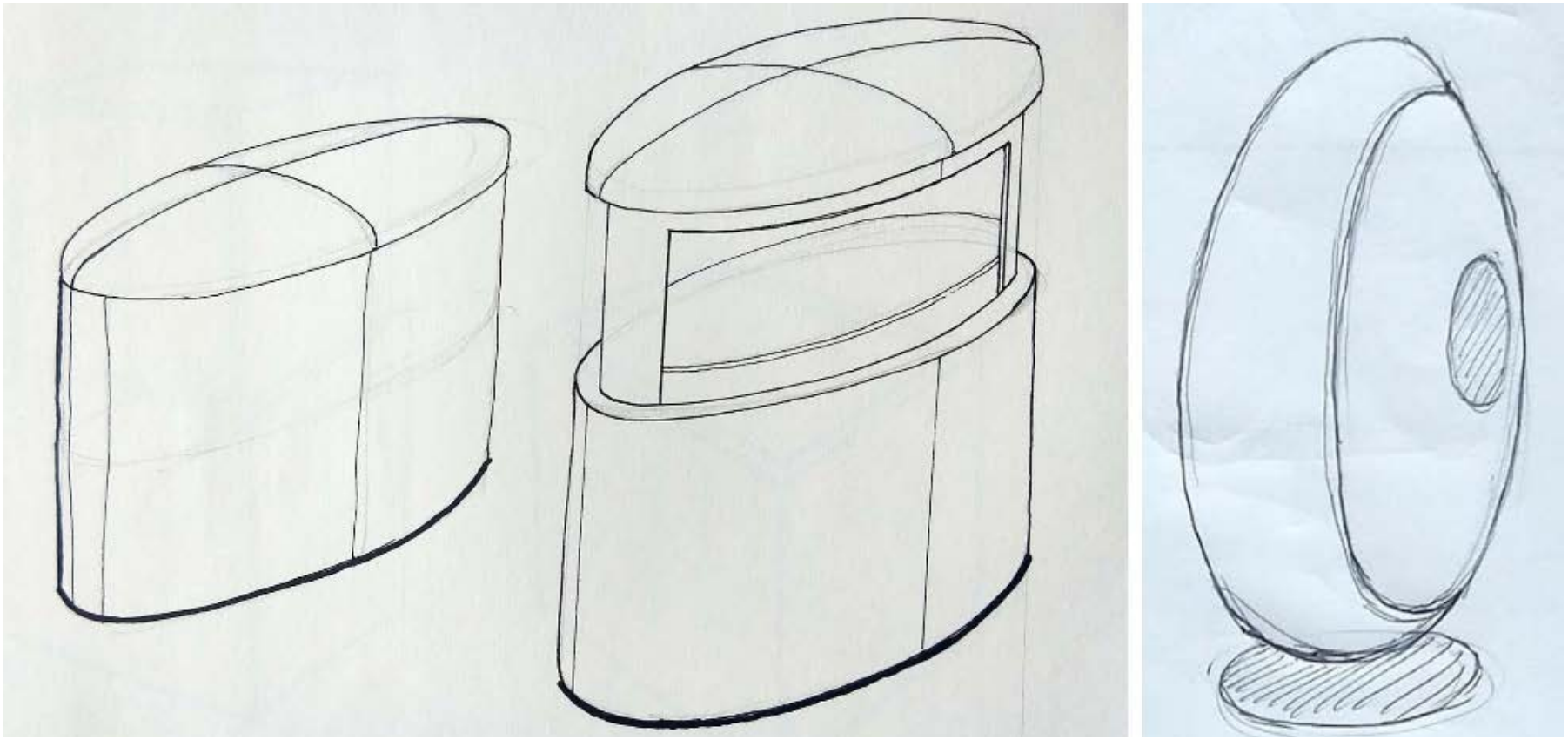

Figure 3.17 Ideation sketch seven

Keywords - Minimalistic, smooth, organic, unconventional, iconic

3.5.8 Ideation 08

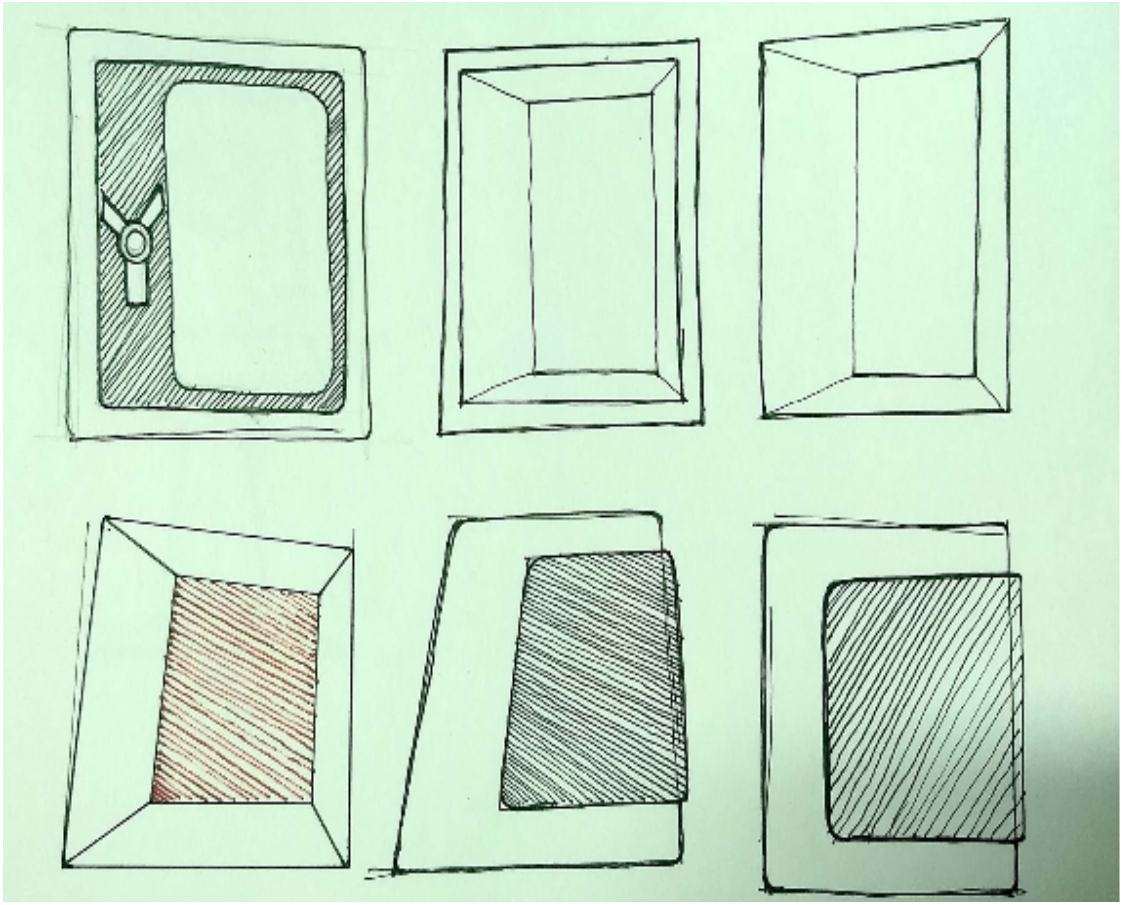

Figure 3.18 Ideation sketch eight, more simplistic

Keywords - simple, boxy, doable

3.6 Types of material and finishes

Figure 3.19 Types of material finishes we can use. It's the true material finish

3.7 Ways of customization of the product

Level 1: Altering the look and feel of the product:

To meet customer tastes

- Patterns on front facia
- Color Options
- Laser etching
- Embossing
- Custom graphics
- Interior Layout

Level 2: Modifying the functionality of the product:

By changing how the product functions, you can tailor product based on customer needs.

- Changing the level of security
- Adding additional attributes (Fire safe, waterproof etc..,)

3.8 Concept

3.8.1 Concept 01

- Straight lines
- Tight Radius
- Large chamfers
- Contrasting colours
- Rigid
- High quality

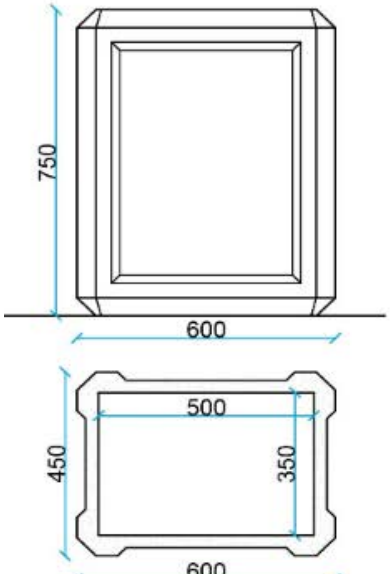

Figure 3.20 CAD of concept one

Figure 3.21 3d rendering of Concept one

Figure 3.22 Color variation of concept one

Figure 3.23 Material variation of concept one

3.8.2 Concept 02

- Organic
- Generous radius
- Approachable
- Modern
- Unconventional
- Iconic

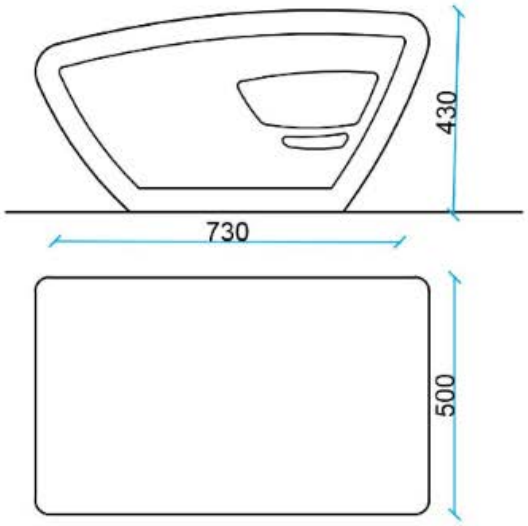

Figure 3.24 - CAD of concept two

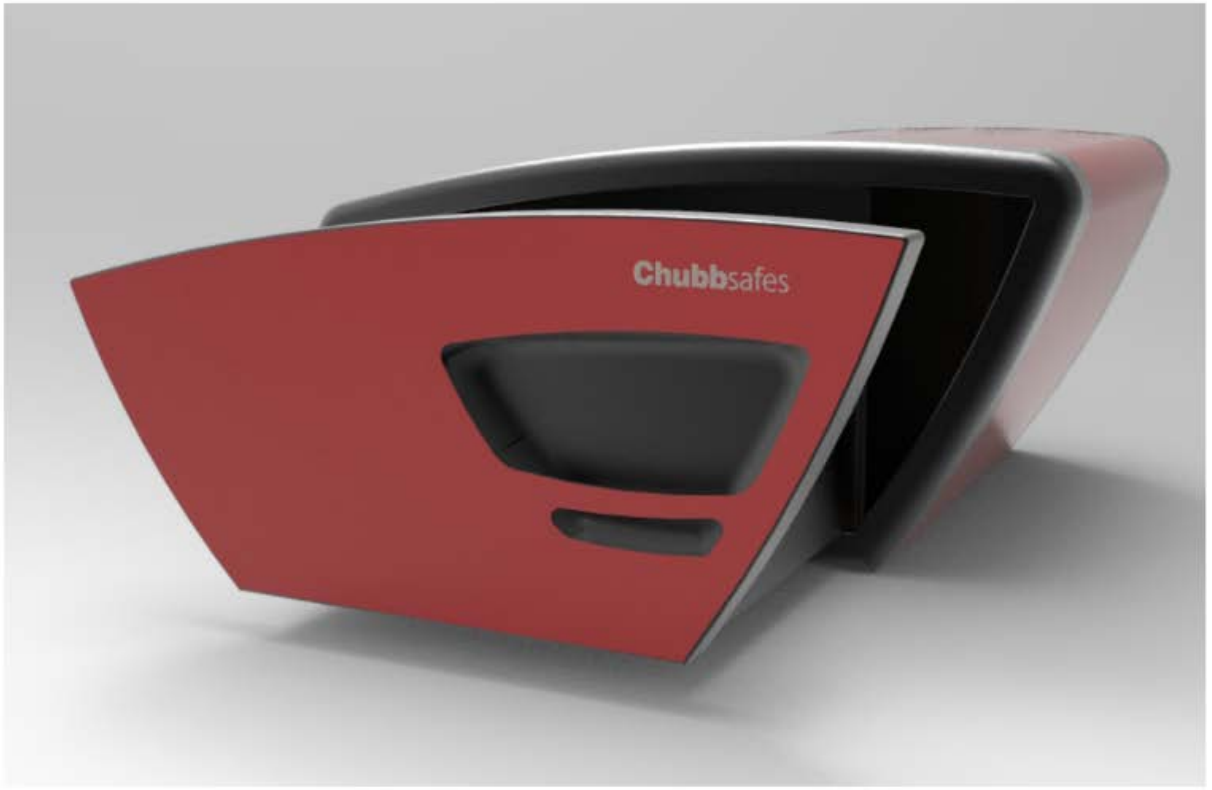

Figure 3.25 3D rendering of concept two

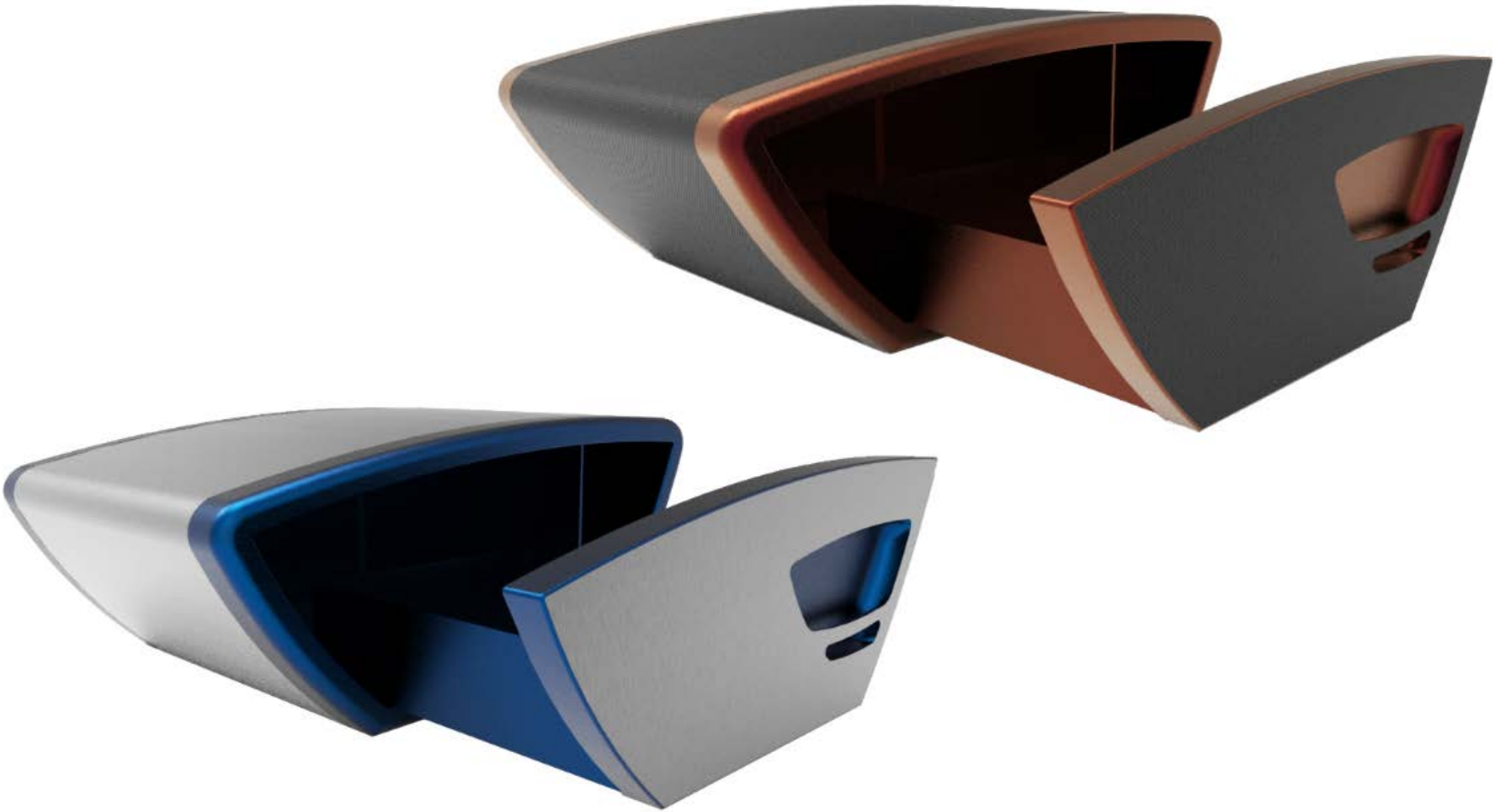

Figure 3.26 Color variations of concept two

Figure 3.27 Color variations of concept two

3.8.3 Concept 03

- Angular
- Imposing
- Luxury
- Distinctive elements
- Concentric Shapes
- Oblong patterns

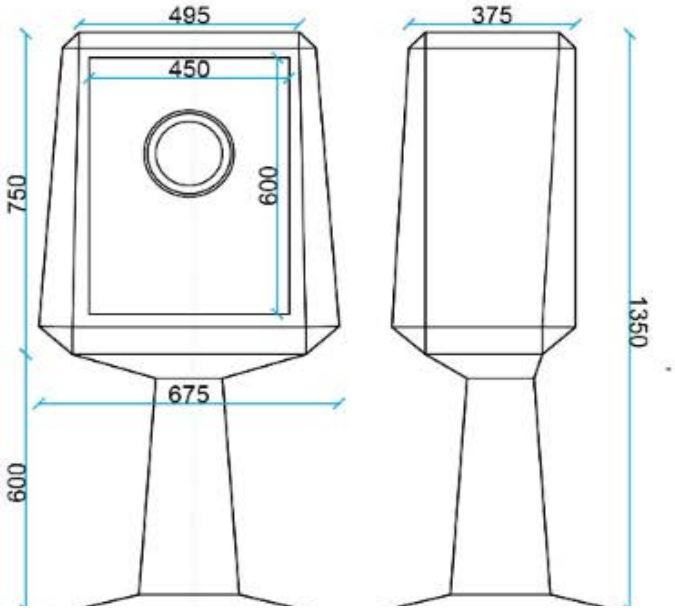

Figure 3.28 CAD of concept three

Figure 3.29 3D rendering of concept three

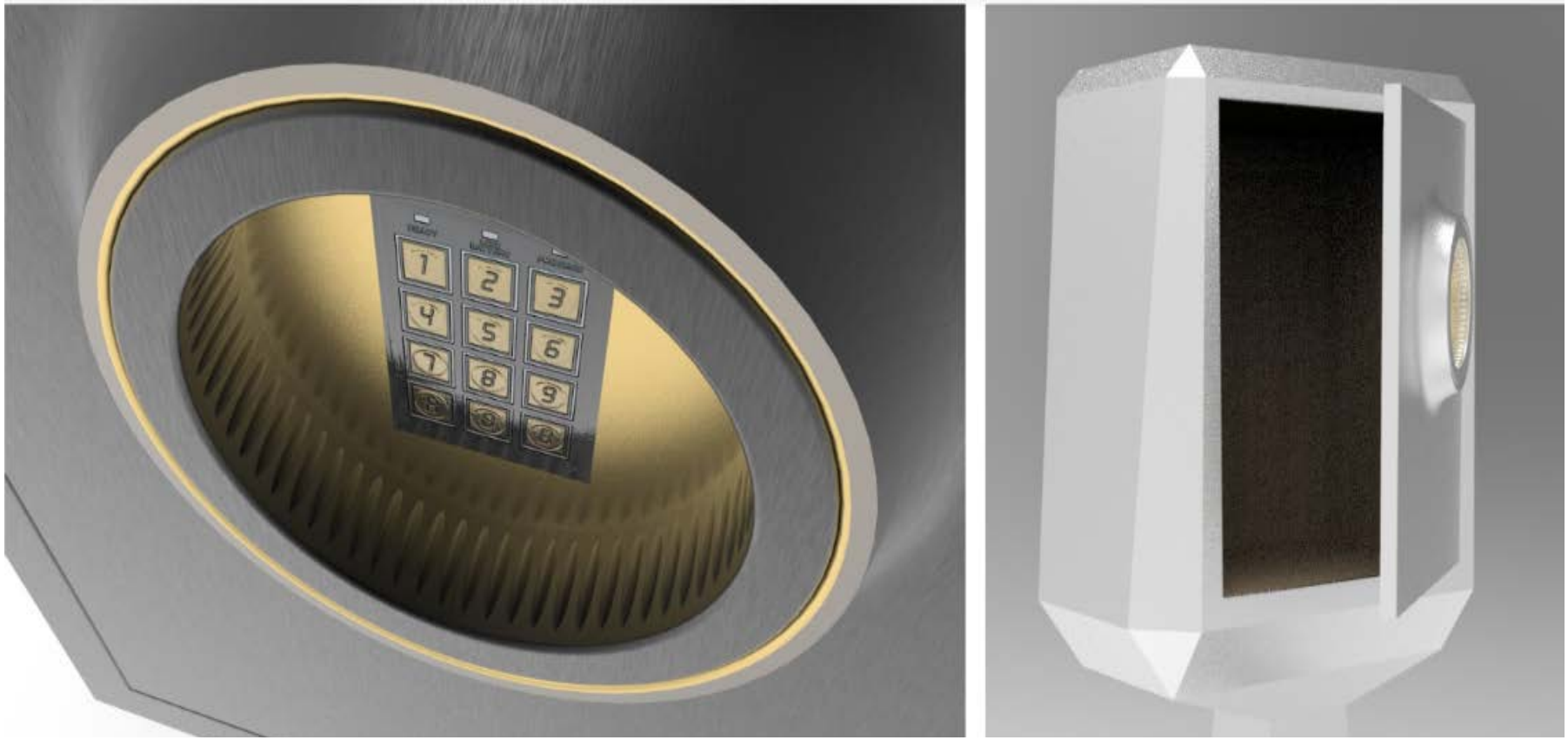

Figure 3.30 Details of concept three

Figure 3.31 Color variations of concept three

3.8.4 Concept 04

- Organic
- Generous radius
- Approachable
- Modern
- Unconventional
- Iconic

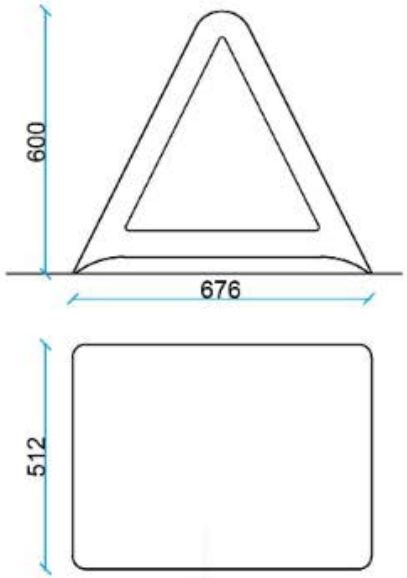

Figure 3.32 CAD of concept four

Figure 3.33 3D rendering of concept four

Figure 3.34 Color variations of concept four

3.8.5 Concept 05

- Straight lines
- Tight Radius
- Large chamfers
- Contrasting colours
- Rigid
- High quality

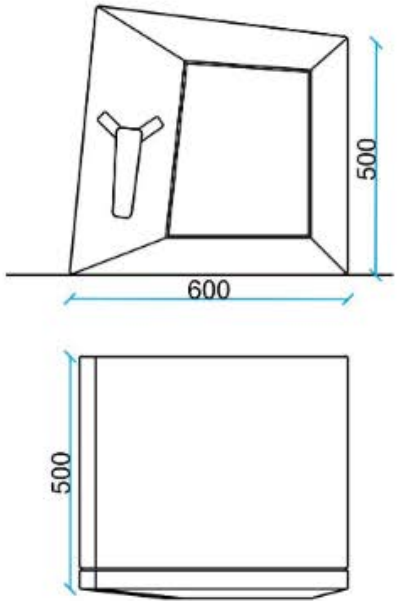

Figure 3.35 CAD of concept five

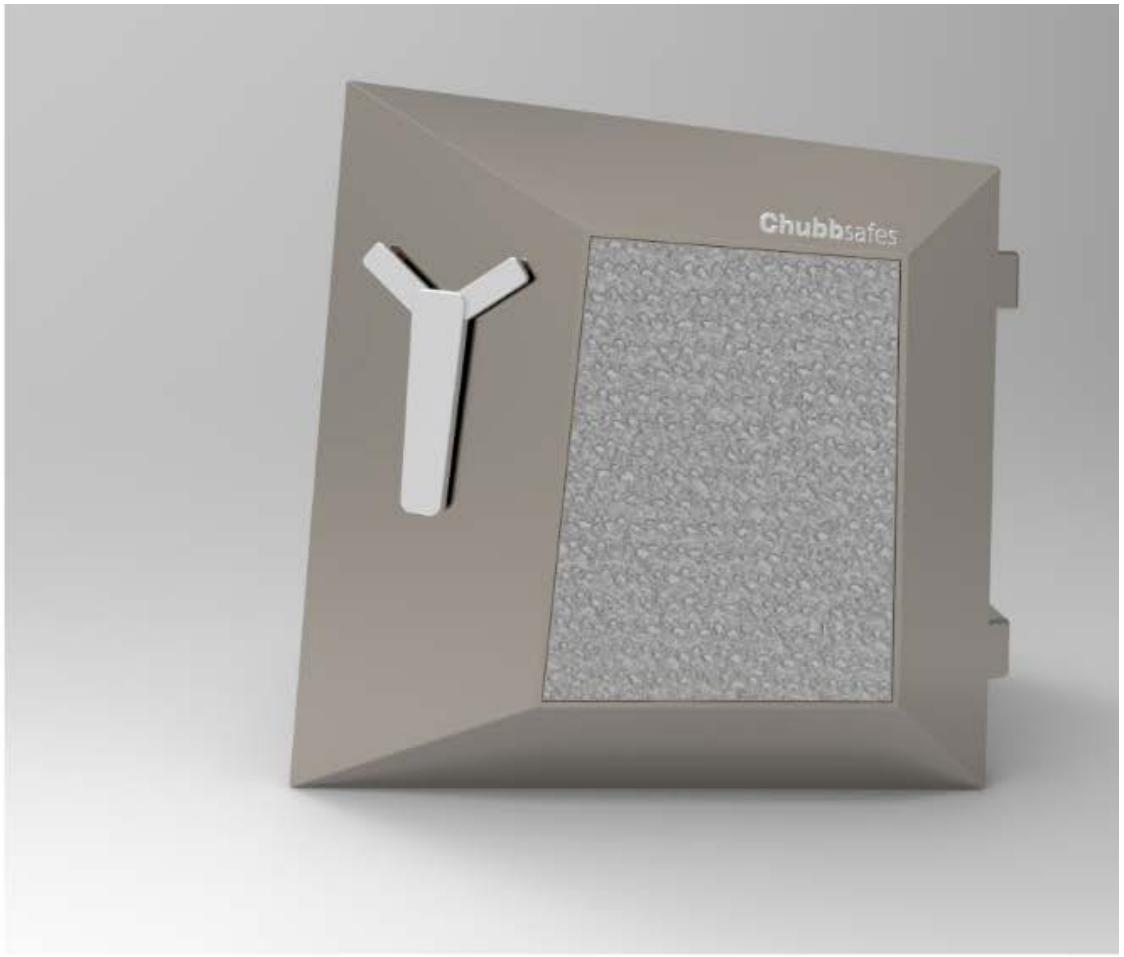

Figure 3.36 3D rendering of the concept five

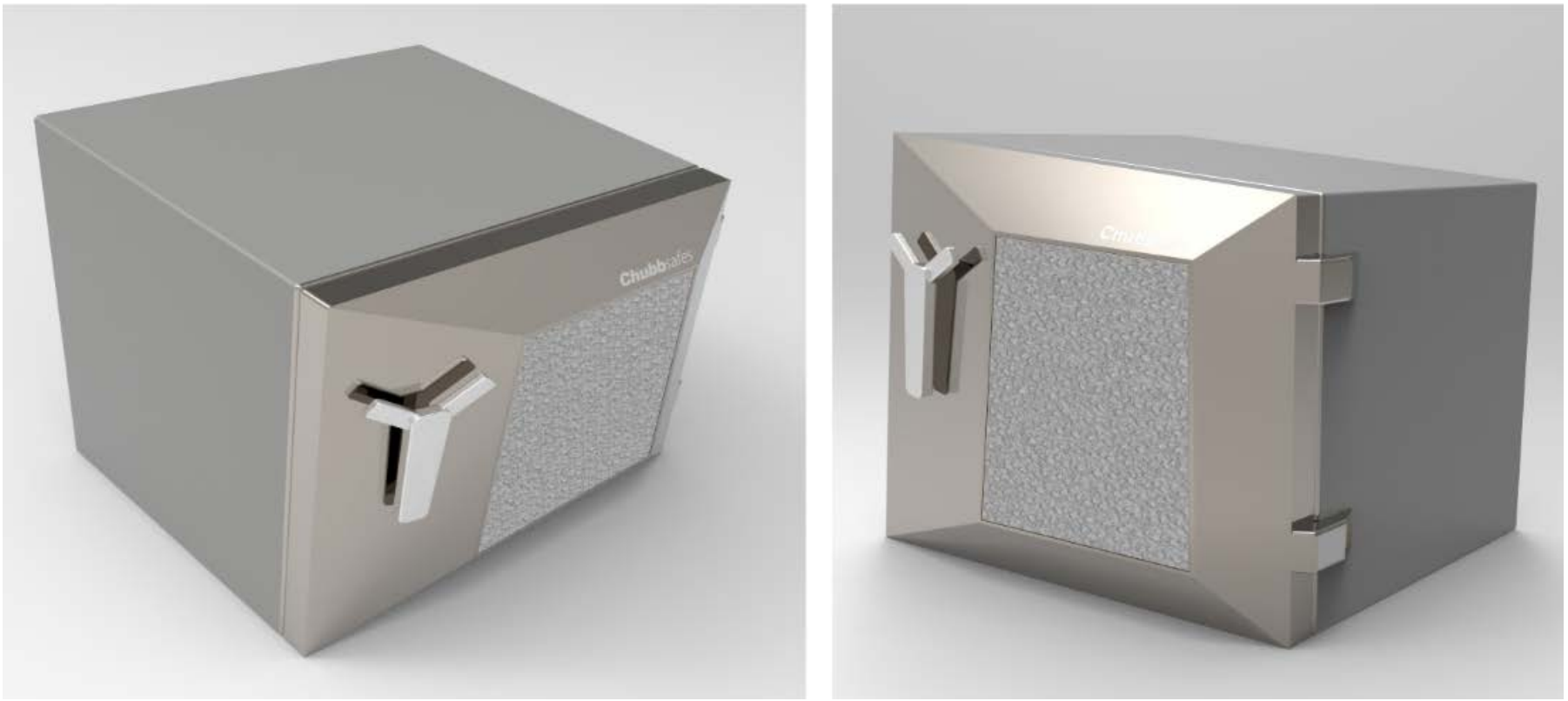

Figure 3.37 3D renderings of the concept five

3.8.6 Concept 06

- Straight lines
- Smooth Radius
- Contrasting colours
- Rigid
- High quality

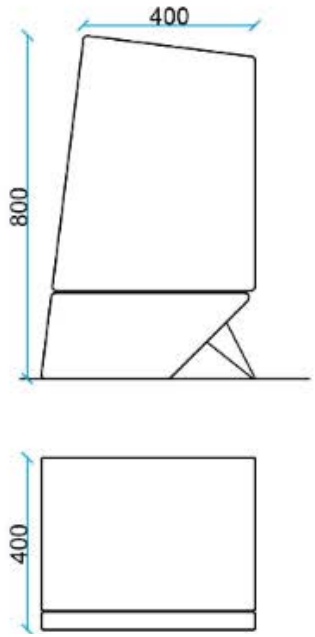

Figure 3.38 - CAD of concept six

Figure 3.39 - 3D rendering of the concept six

Figure 3.40 3D rendering of concept six

3.9 mock ups

To get the physical touch & feel of the forms i made scale models of all concepts from MDF.

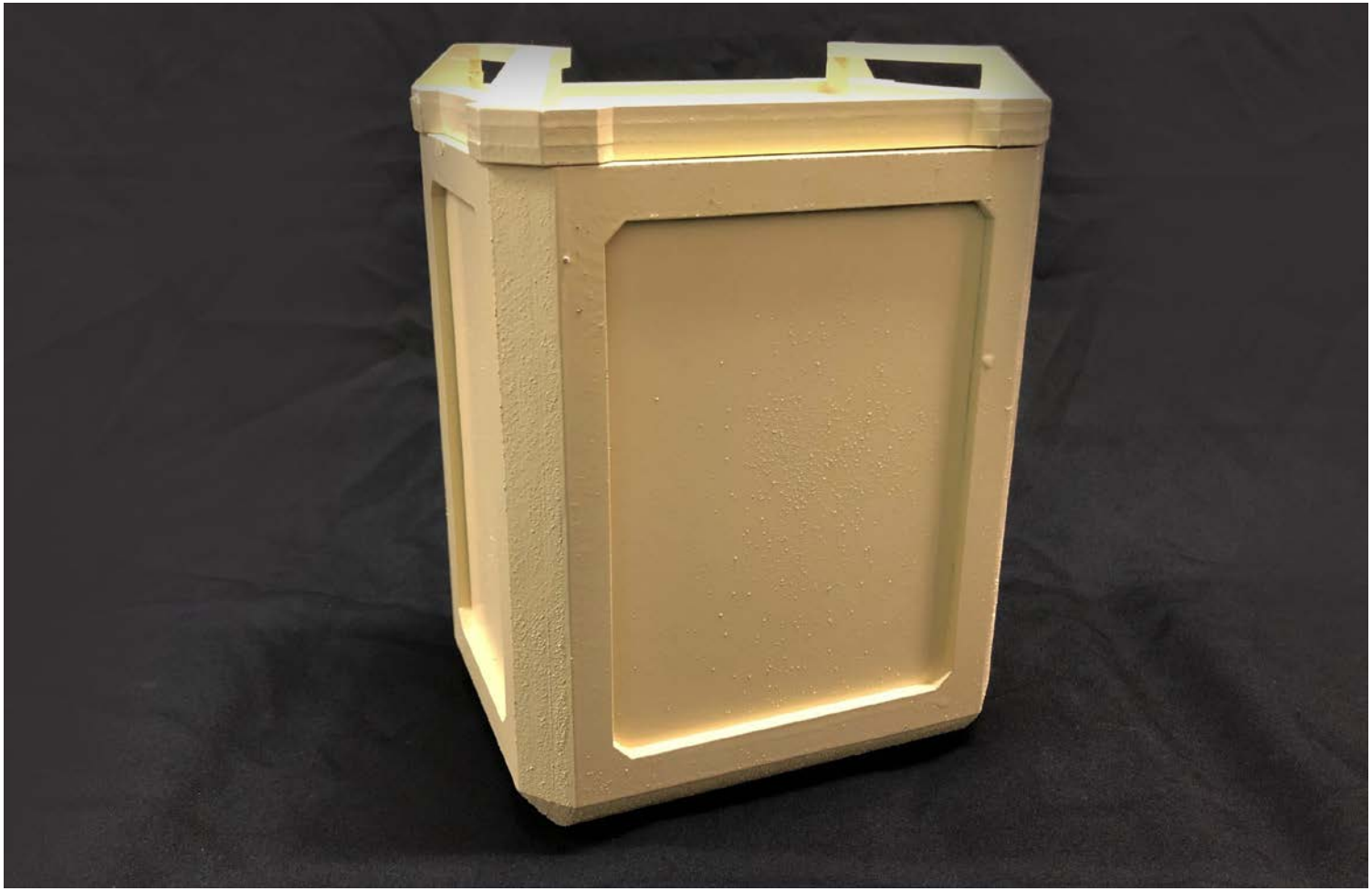

Figure 3.41 Scale mode of concept one

Figure 3.42 scale model of the concept two

Figure 3.43 Scale model of concept three

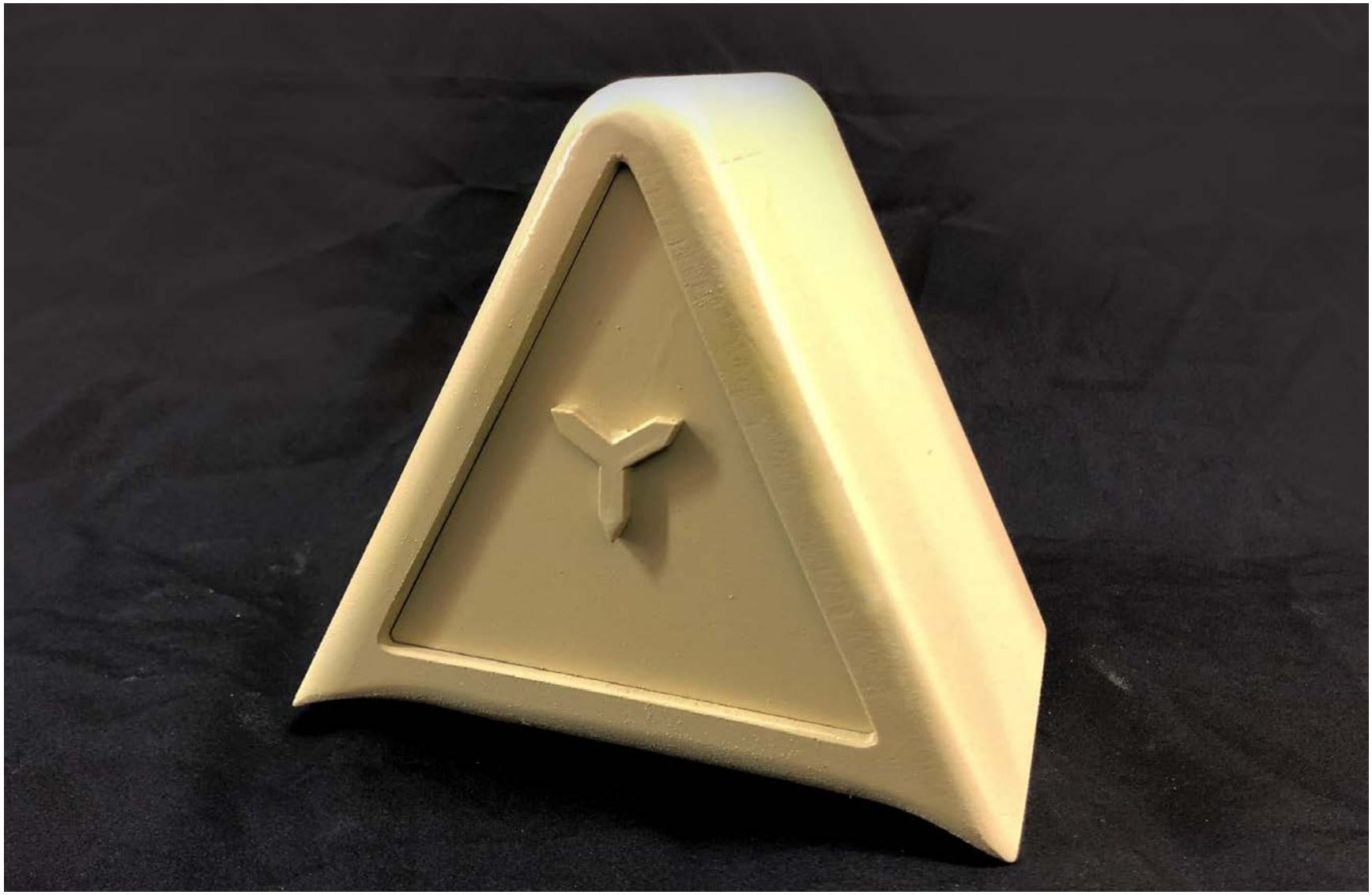

Figure 3.44 Scale model of concept four

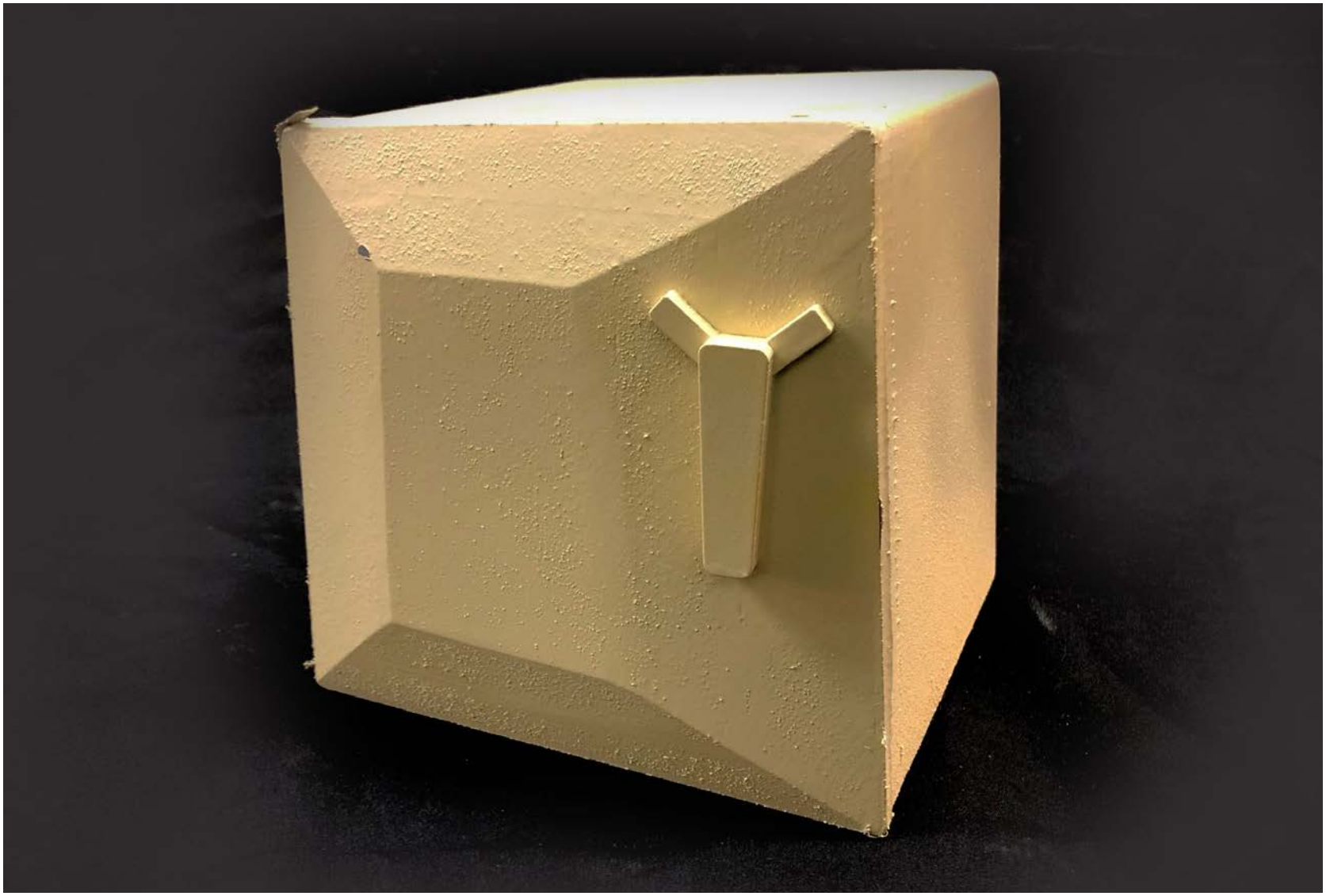

Figure 3.45 Scale model of concept five

Figure 3.46 Scale model of concept six

3.10 Concept evaluation

I tested the concepts with my friends and some people in campus with the scale models and 3D renders of the concepts and explained them the concepts. Then asked them to rate the concepts out of 10 in attributes like **Usability, Footprint, Manufacturing Cost, Novelty, Manufacturability, Fascia Customization**. People tried it and rated the concepts with their understanding from scale models and 3D renderings.

Based on my design brief **Usability, Footprint, Cost due to complexity, Manufacturability** are four primary concern for the design. Therefore i am giving them equal weightage while evaluating the concepts.

Figure 3.47 - Concept evaluation table

	Concept 01	**Concept 02**	**Concept 03**	**Concept 04**	**Concept 05**	**Concept 06**
Usability	7	5	8	4	8	8
Footprint	6	4	7	4	8	8
Cost due to complexity	3	5	6	6	8	8
Manufacturability	5	5	7	6	9	7
Total	21	19	28	20	**33**	**31**

.

The concept 05 got highest ratings. As concept 06 is very close to rating of concept 05, I am selecting concept 05 and 06 for further evaluation. This further evaluation will be based on the Novelty and Fascia Customization.

Figure 3.48 - Concept evaluation table.

	Concept 05	Concept 06
Previous score	33	31
Novelty	8	7
Fascia Customization	8	6
Total	**49**	**46**
	Concept 05	**Concept 06**

3.11 Volume variation

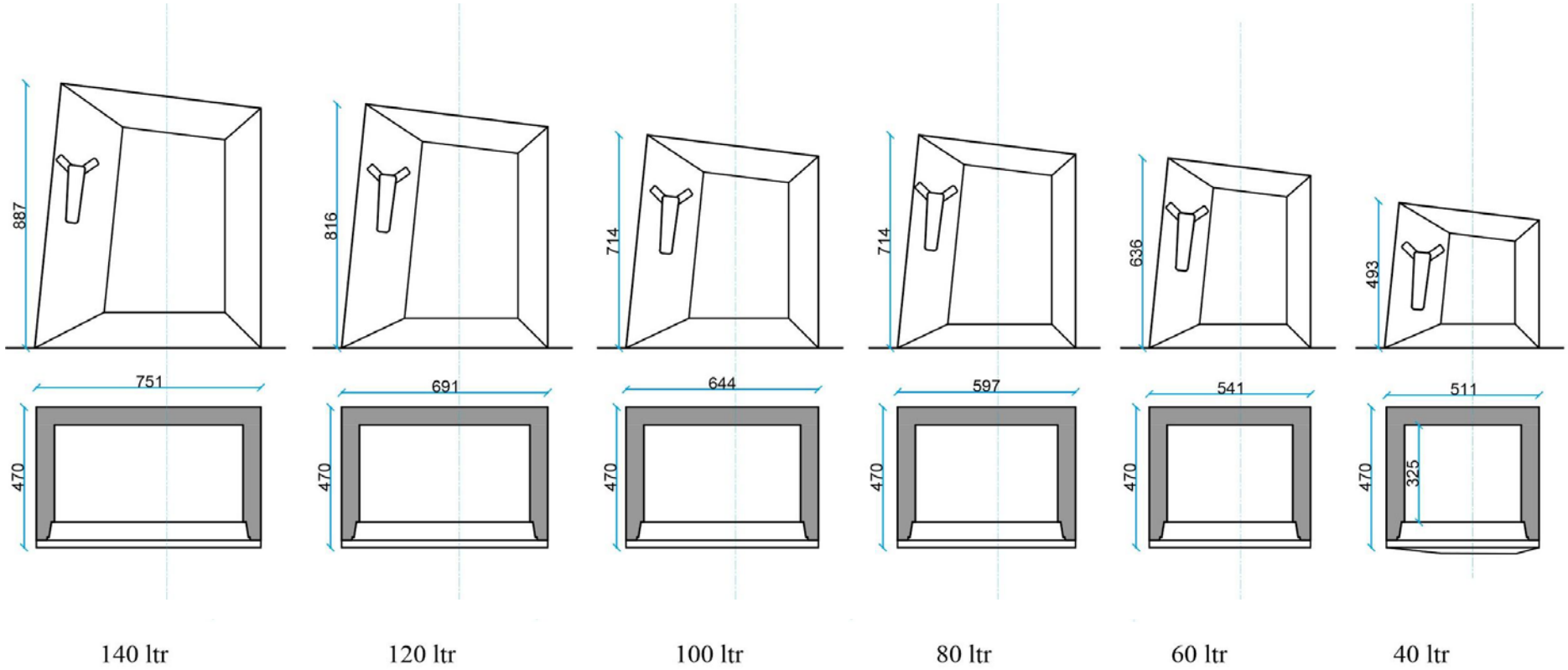

Figure 3.49 - Volume variation of concept 05

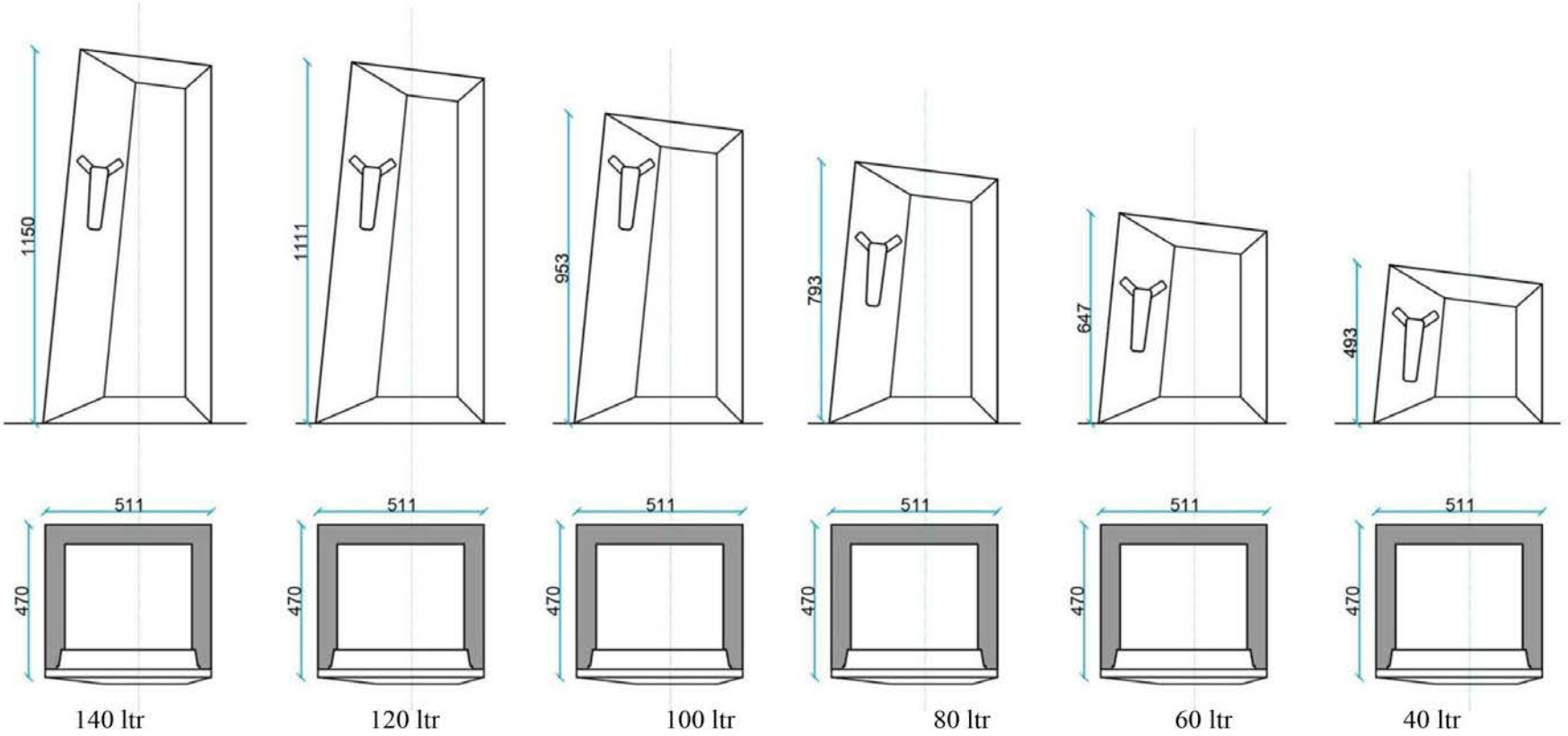

Figure 3.50 - Volume variation of concept 05

3.12 Colour variation

Figure 3.51 - Colour Mood board for Feminine

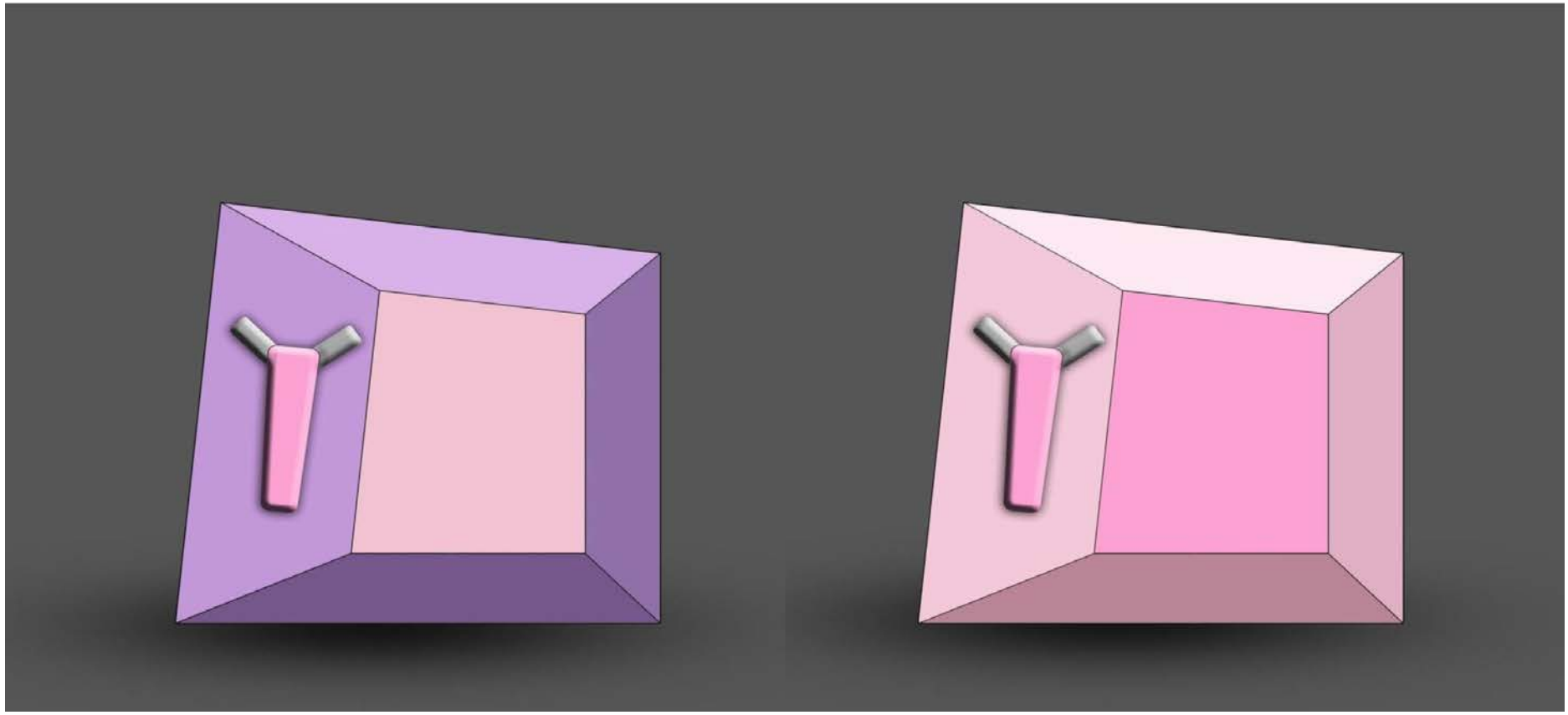

Figure 3.52 - Colour variation of concept 05 for feminine

Figure 3.53 - Colour Mood board for Modern

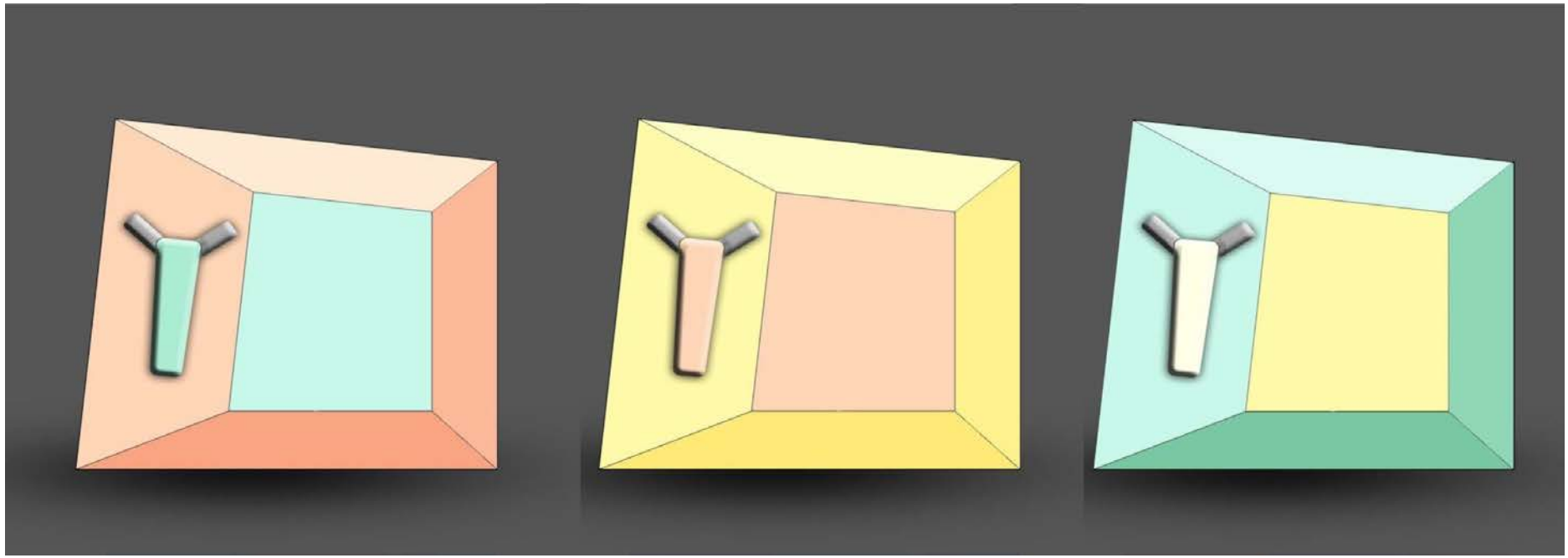

Figure 3.54 - Colour variation of concept 05 for Modern

Figure 3.55 - Colour Mood board for Retro

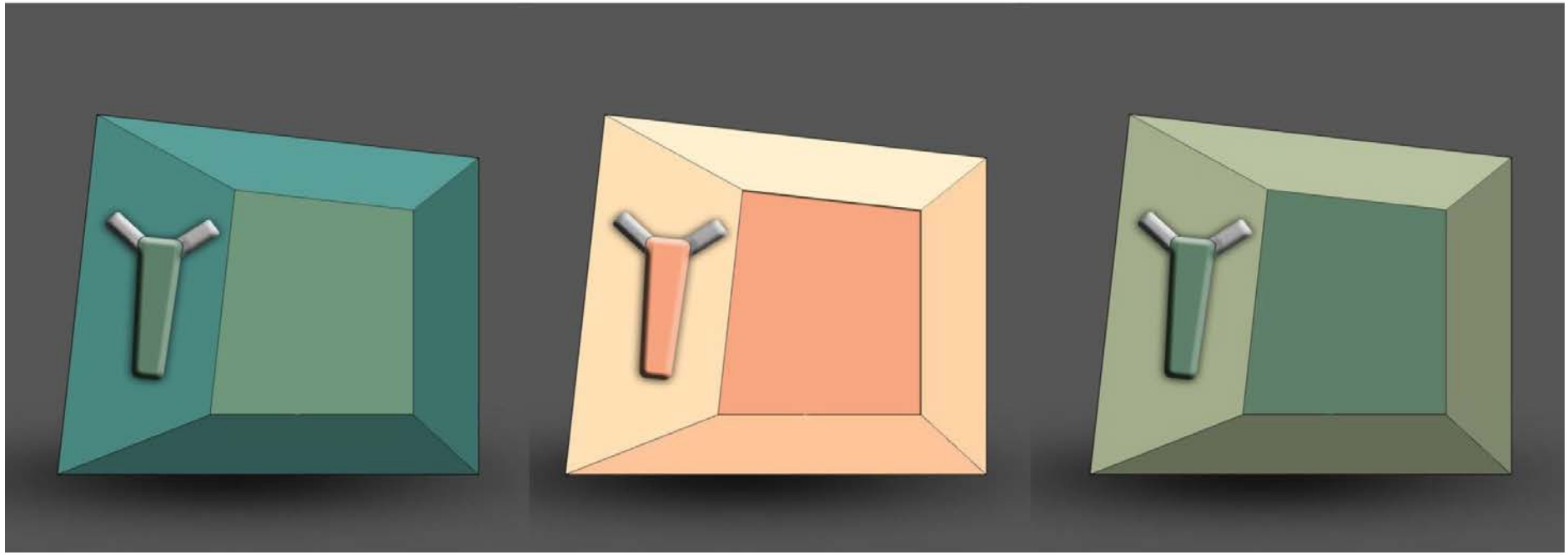

Figure 3.56 - Colour variation of concept 05 for Retro

Figure 3.57 - Colour Mood board for Formal

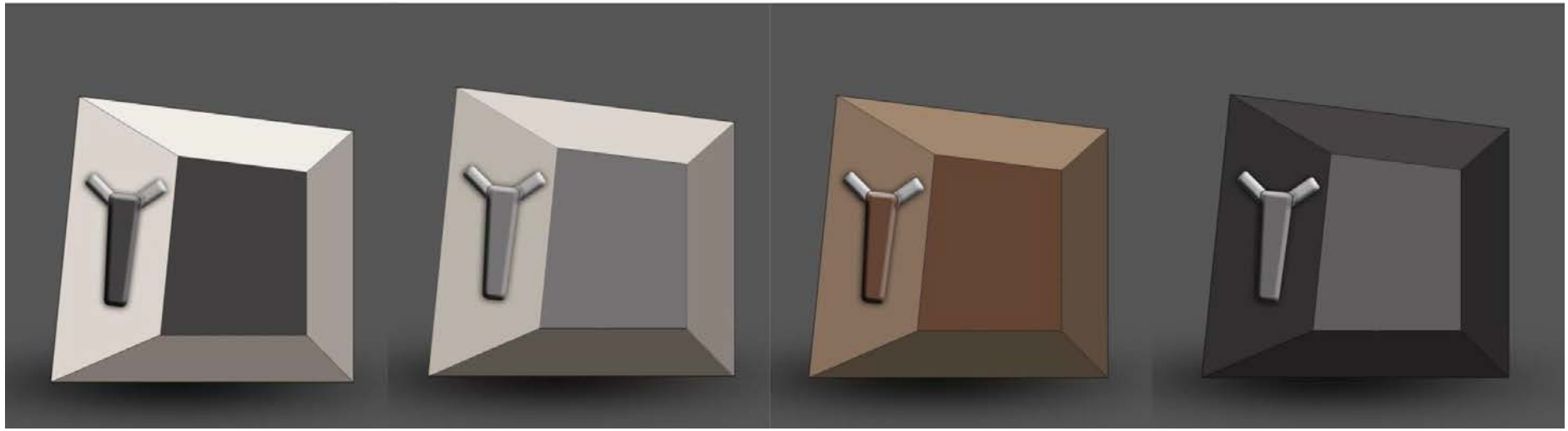

Figure 3.58 - Colour variation of concept 05 for Formal

3.13 Interior Details

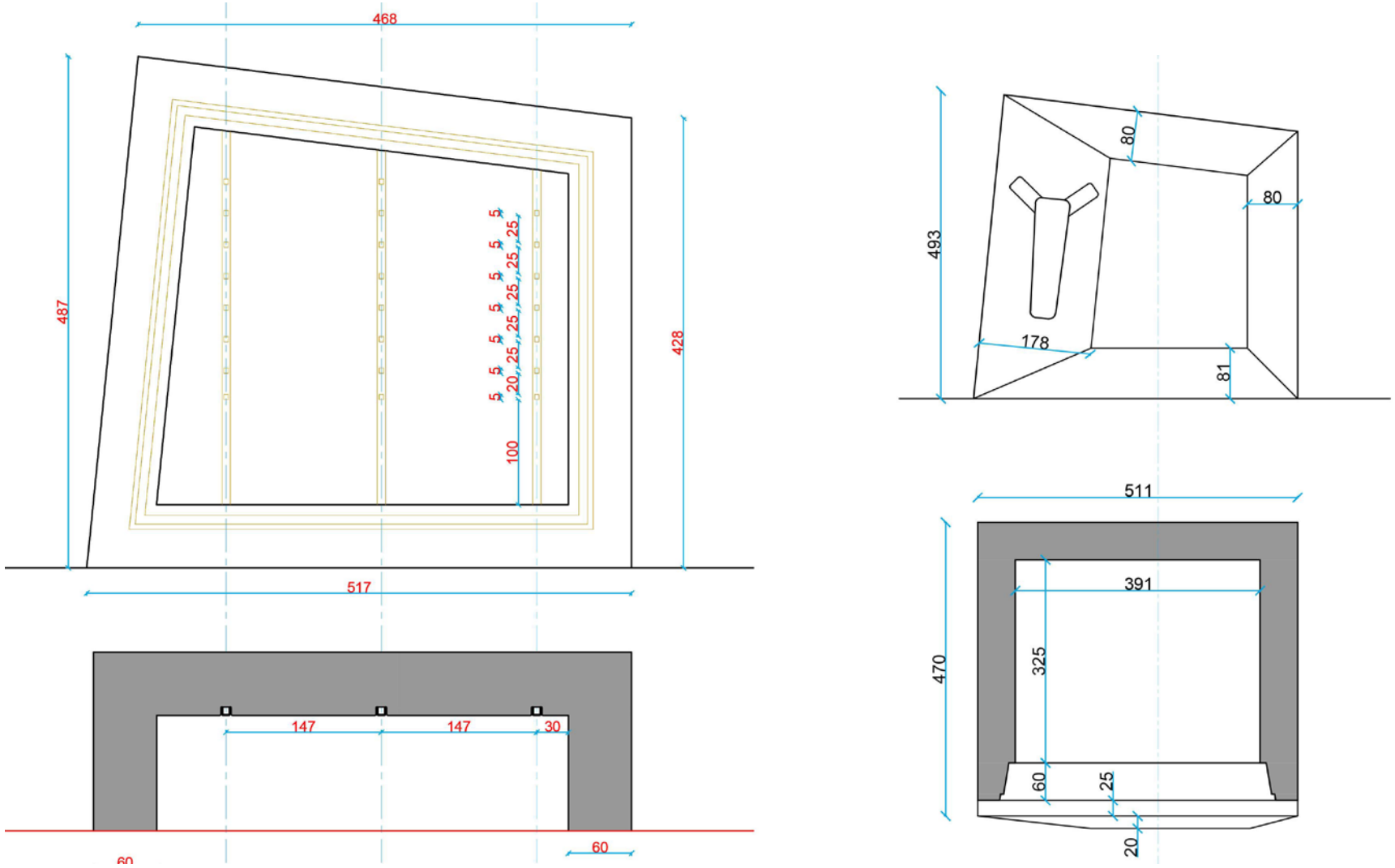

Figure 3.59 - Interior details with the outre dimensions

Figure 3.60 - Interior details 3D visualisation

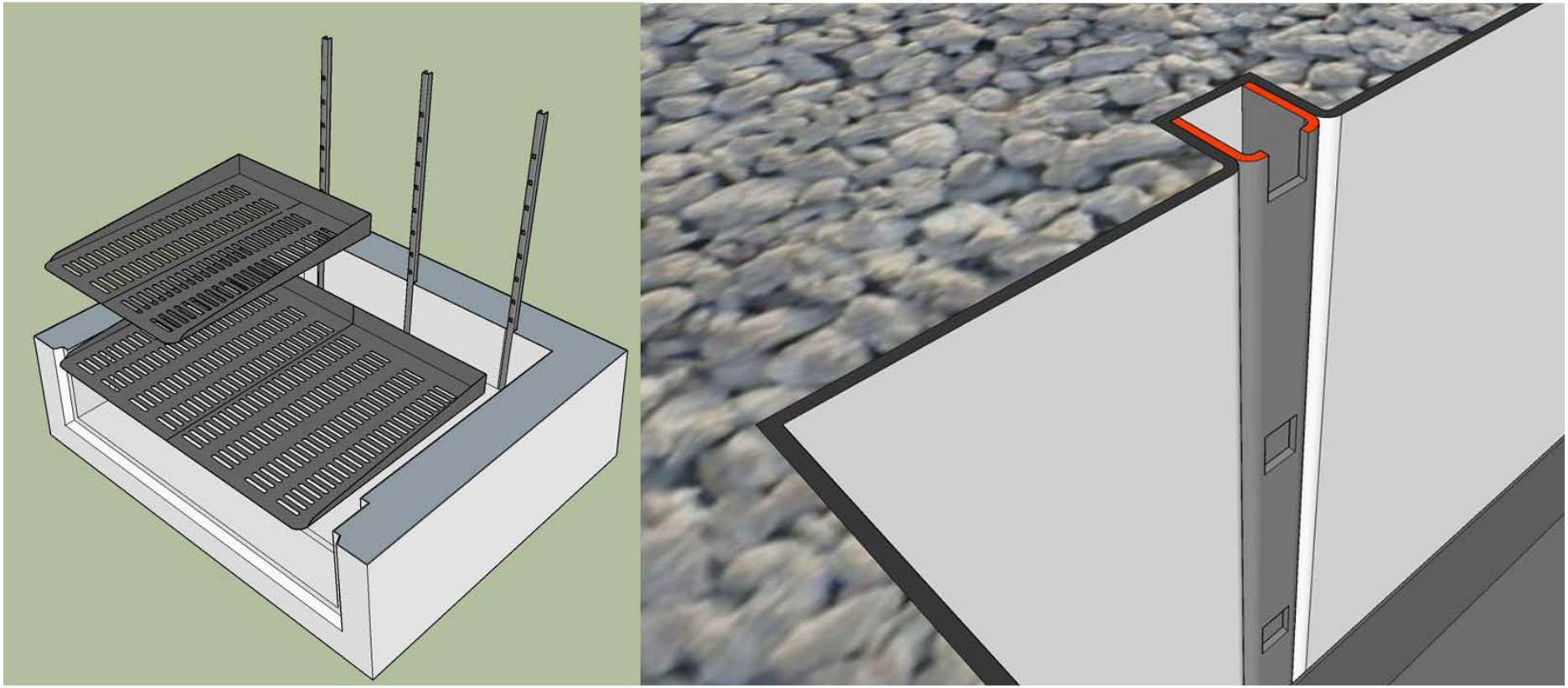

Figure 3.61- Interior details 3D visualisation

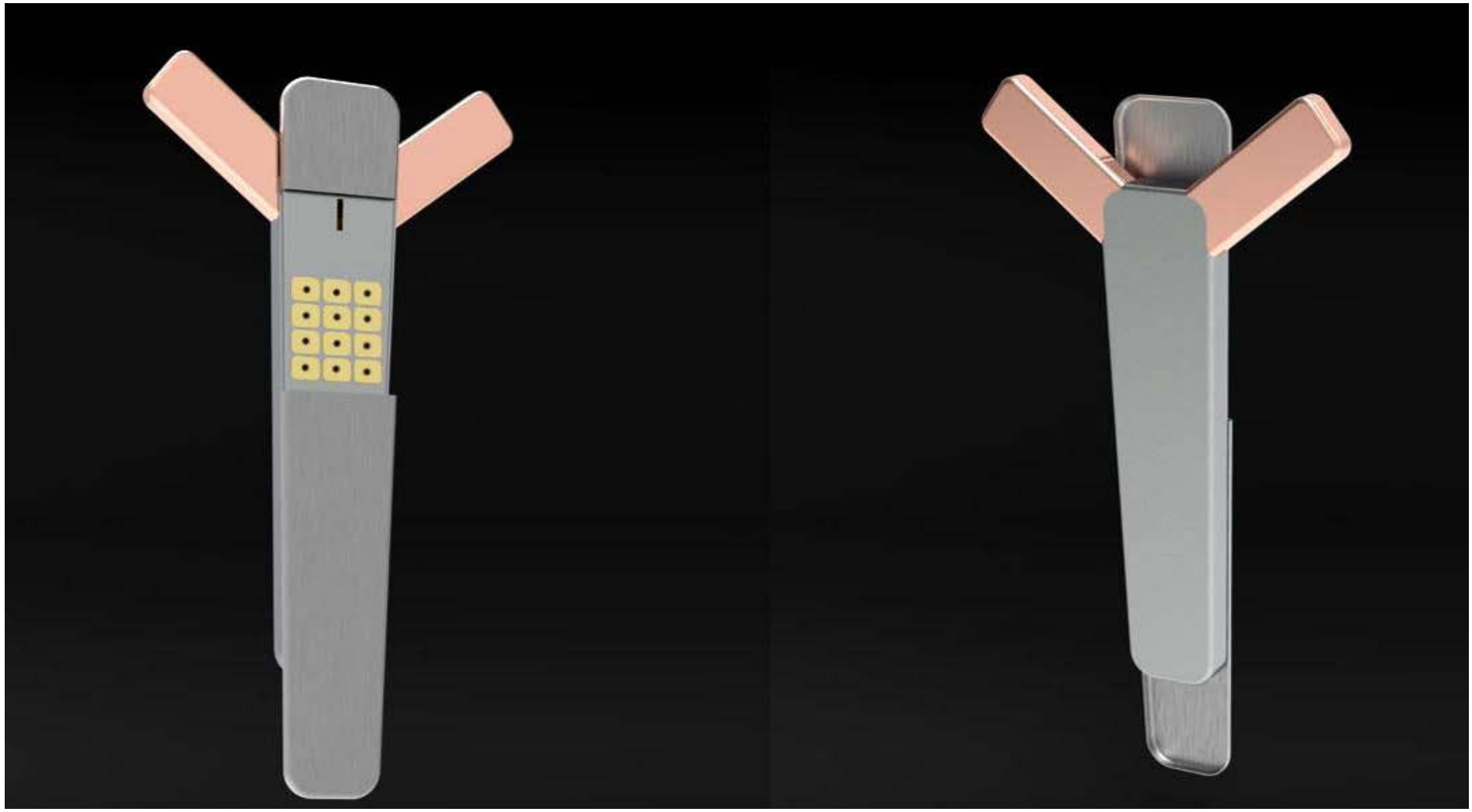

Figure 3.62- Handle details 3D visualisation

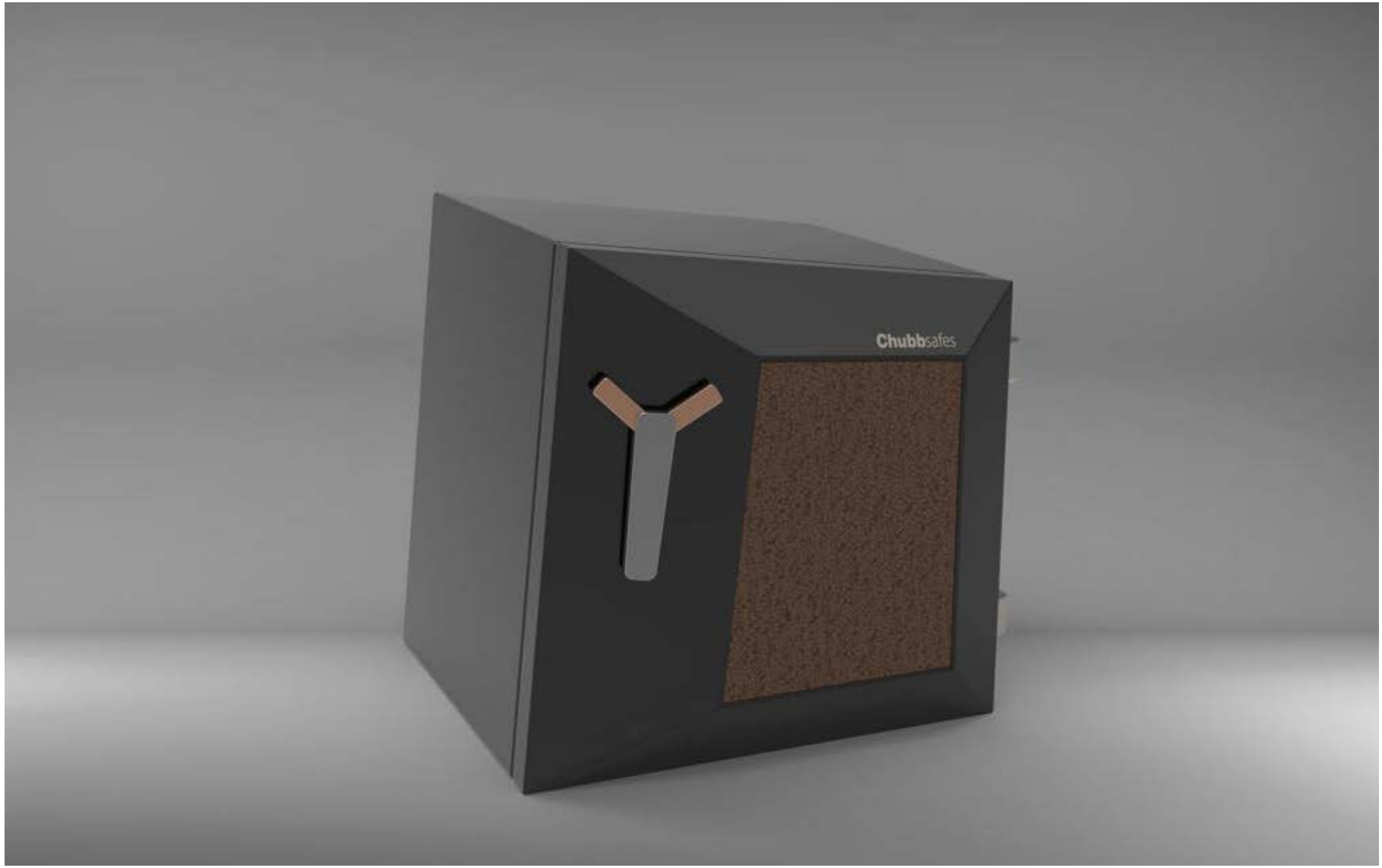

Figure 3.63- Final 3D visualisation

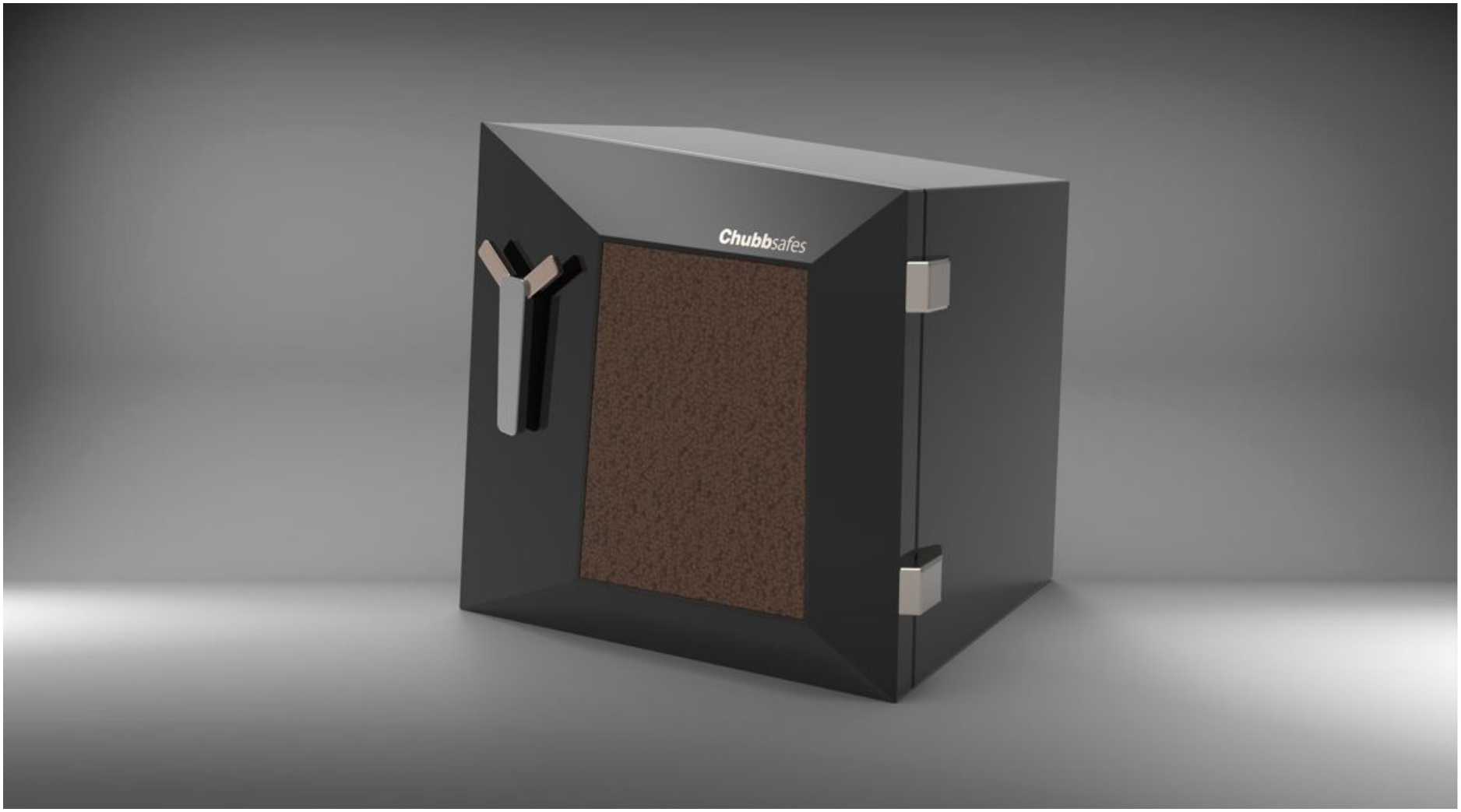

Figure 3.64- Final 3D visualisation

Figure 3.65- New Material details

Sl. no	Name of the component	Material	Properties
1.	Outer shell	Iconel	Light, corrosion resistant, High impact strength and temparature resistant.
2.	Core/ Filling	CFoam	Fire retardant
3.	Shelf	Lexan	Flexible ,high impact resistant and handles 240^0 C before deforming
4.	Lining	Wool felt	Renewable, soft touch
5.	Handle	Stainless steel	Extremely strong, long lasting and rust resistant.
6.	Hinges	Titanium	High strength-to-weight ratio, and extreme temperature and corrosion resistance.

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