Design Of A Household Dishwasher

Project III

By

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Approval sheet

The product design project titled "**Design Of A Dishwasher**" by Vaibhav Gadade is approved as a partial fulfillment of the requirements for the postgraduate degree of

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Abstract

The first dishwasher was invented as early as 1850, and it has come a long way since then to become commercial success in America and Europe. With the combination of mechanical and chemical (advanced detergents) wash they have today become highly efficient and the days of unsatisfactory cleaning are gone.

But as far as India is concerned, they have failed to make an impact. A place where washing machines have become a house hold appliance and even the microwaves are these days being considered a necessity, the dishwasher is still considered a risky investment, especially when there is cheap labour available. But there are fallouts with the maid system too in terms of hygiene and flexibility of time.

Seeing a window of opportunity, I took up this project as a design challenge to overcome the drawbacks of the existing American dishwasher models, adapt them to fit Indian utensils and make them more efficient in terms of **size and usability.**

Contents

1 Introduction

Ask any woman and she will say that doing the dishes after meals is the most unwilling job they have to do. In this age of modernization and liberation where a variety of gadgets and products have come in to the market to assist a woman's every need, right from microwaves for cooking to vacuum cleaners for cleaning the house, hi tech programmable washing machines to wash the clothes, and refrigerators to serve her every need, nothing has been done about taking care of the soiled dishes. And we all know that after a full meal we would just like to rest and relax for a while and not tend to do the boring chore. Most Indian homes, to tackle this have got a maid who comes once a day to do the dishes. Dishes are rinsed and kept over night in the sink till the maid comes the following day, usually after lunch to wash the dishes of the two meals.
All this because manual labour is extremely cheap in India and no comprehensive dishwasher has been yet made to suite Indian kitchens and cooking habits.
Hence the main intention of the project is to analyze the failure of the dishwasher in the Indian market, **ascertain its need** and bring out a more efficient device in terms of operation and the space it occupies and which is both economical and easy to use.

1.1 History of dishwasher

The first dishwasher was invented in America in 1850, Joel Houghton patented a wooden machine with a hand-turned wheel that splashed water on dishes, it was hardly a workable machine, but it was the first patent.

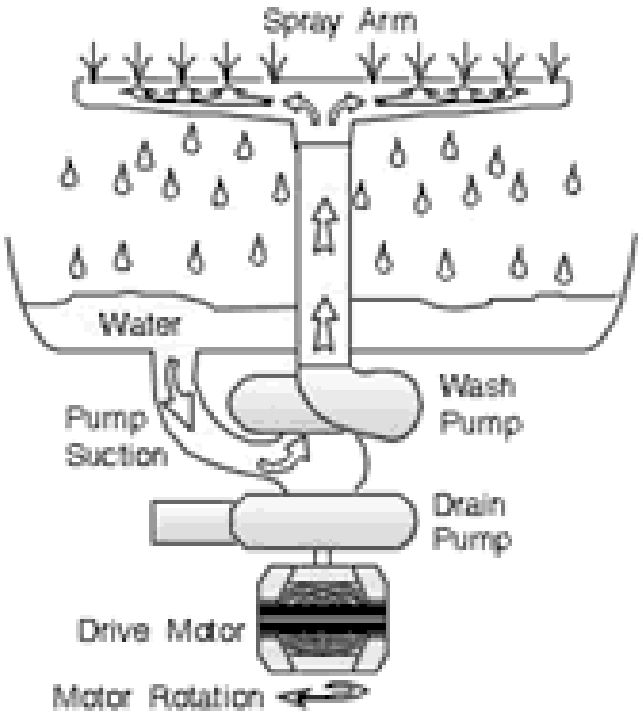
In 1865 L.A. Alexander obtained a patent for a device that used a hand crank and gearing to spin a rack of dishes through the dishwater again this didn't do to much to clean dirty dishes.

In 1886, Josephine Cochrane proclaimed in disgust "If nobody else is going to invent a dishwashing machine, I'll do it myself." And she did, Cochrane invented the first practical dishwasher. Cochrane had expected the public to welcome the new invention, which she unveiled at the 1893, World' Fair, but only the hotels and large restaurants were buying her ideas.

In 1886, Josephine Cochrane proclaimed in disgust "If nobody else is going to invent a dishwashing machine, I'll do it myself."

Cochrane's machine was a hand-operated mechanical dishwasher. As this was before electricity was widespread. She founded a company to manufacture these dish washers, which eventually became KitchenAid. Other companies produced dishwashers that were powered by steam and designed for restaurants and caterers. They usually worked by passing the dirty dishes under jets of hot water by means of a conveyor belt or a revolving basket. They were generally inefficient. It was not until the 1950s, that dishwashers caught on with the general public as they became cheaper and a more usable size. Josephine Cochrane was quite wealthy and granddaughter of John Fitch the inventor of the steam boat. She never washed dishes herself and only invented the dishwasher as servants were chipping her nice china.

1.2 How a dishwasher works



A dishwasher combines water with detergent, heats the mixture and sprays it against the dishes. It pumps out the dirty water and then rinses the dishes with clean water mixed with a rinse agent. After pumping out the rinse water, the dishes are dried by either heating or air drying them. The selector switch allows you to pick a variety of cycles which vary the length of wash, water temperature and drying temperature.

When the door latch is closed, the door switch is engaged and allows the dishwasher to operate. Based upon the chosen cycle, the selector switch signals the various components to operate at the appropriate stage of the cycle. The timer regulates the length of each stage of a cycle.

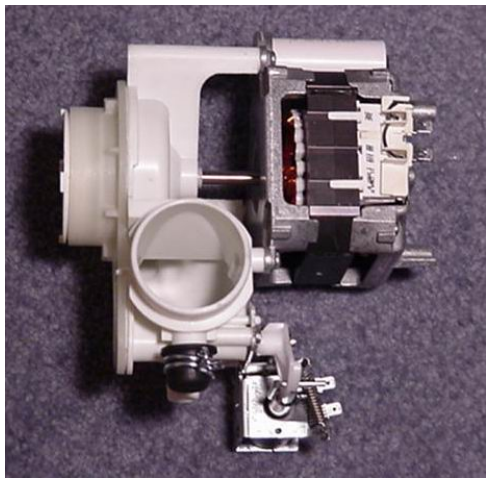
The water inlet valve fills the tub with water. A float in the tub prevents the dishwasher from overfilling. Either the float or the timer signals the inlet valve to close. The detergent is then released into the tub. In many dishwashers the mixture is heated with an electric heating element. Water that is not warm enough results in poor cleansing.

The motor turns a pump which forces the water up through the spray arms and spray tower (if any). The pressure of the water causes the arms to turn.

Some dishwashers have a two-way motor. When it turns in one direction, it pumps the water through the spray arms. When it turns the other way, it pumps the water out through the drain. If the motor only turns in one direction, then an actuator moves to channel the water either to the spray arms or to the drain.

After the detergent cycle is complete the dishes are rinsed. If the dishwasher has a rinse agent feature, the rinse agent is added to the rinse water.

Once the rinse cycle has completed and the water has been pumped out, the dishes are dried. A electric heating element heats the interior of the dishwasher. Some dishwashers also have fan to circulate the air. A thermostat prevents the dishwasher from overheating.



Pump and motor assembly

The motor and pump system

Your dishwasher has at least one motor. It is attached to a pump, which forces the water up into the sprayer arms. During the drain cycle, it also pushes the water out of the dishwasher...down the drain. A few European dishwashers use two separate motors, one for spraying and one for draining. The motor is behind an access panel beneath the dishwasher. Some models have reversible motors, others don't.

The controls, switches, valves, and solenoids

A dishwasher has at least three, but often six or more controls, switches, valves and solenoids. We will discuss these:

Timer
Selector switch
Water inlet valve
Float switch
Soap dispenser
Rinse aid dispenser
Drain solenoid
Thermostat
Soil sensors
Door switch
Drying fan
Heating element

Inlet valve

Soap dispenser

Timer

Dishwashers have a timer behind the main control panel at the front top of the dishwasher, or behind the lower access panel. It is either a mechanical device like a simple clock, or it's completely electronic with just a digital readout. The timer runs the dishwasher in a pre-determined pattern. It provides the electricity to all of the dishwasher components at the correct time, for the correct length of time.

Selector switch

A dishwasher usually has one or more selector switches on the main control panel at the top front of the door. The switch(es) allow you to choose among wash cycles, drying cycles (heat or no heat), temperature of the wash or rinse, and so on. The switches tell the timer which cycle options to engage.

Water-inlet valve

At the bottom left or right of the dishwasher, there's a water-inlet valve behind the access panel. This valve lets water flow into the dishwasher for the wash cycle. It is usually attached to the hot-water supply line, and to a tube that is then attached to the left or right side of the dishwasher. When the timer sends electricity to the valve, it opens and lets water into the dishwasher. The valve stops when the water level trips the float switch or when the timer stops sending electricity to the valve.

Soap dispenser

Dishwashers have a soap dispenser located on the inside of the door. When the timer cycle calls for the soap to be emptied into the dishwasher, it either sends electricity to a bi-metal switch that opens it, or it mechanically opens the soap dish.

Solenoid valve

Float switch

Dishwashers have something meant to keep them from overfilling. This is usually a small switch attached to a float--a float switch. The float, which is usually cylindrical, is inside the dishwasher at the bottom, usually on the left side. As the water level in the dishwasher rises, the float rises too. When it reaches a certain height, the float activates its switch, which cuts the electricity to the water inlet valve. If the water-inlet valve is defective, the dishwasher may overfill.

Rinse aid dispenser

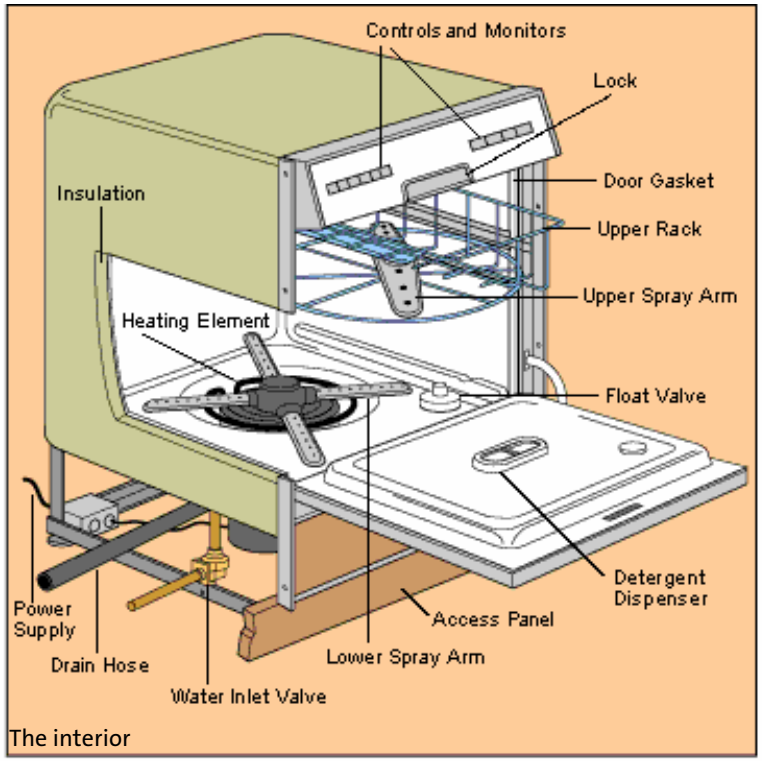
Some dishwashers have a rinse-aid dispenser on the inside of the door. When the timer cycle calls for the rinse aid to be emptied into the dishwasher, it sends electricity to a solenoid switch, which opens the dispenser and measures rinse aid into the dishwasher.

Drain solenoid

Beneath some dishwashers, there's a timer-activated drain solenoid (an electro-magnetic coil) that opens a drain valve, to drain the wash water through a hose and out to the house's plumbing waste system.

Thermostat

Dishwashers have one or more small, cylindrical thermostats. These are a bit larger in diameter than a dime and have two or more wires attached to them. They protect the dishwasher, dishes, and humans by turning off the heating element that heats the water or the air in the dishwasher when it has reached its pre-set temperature. The thermostat automatically re-sets when the temperature falls to a lower level.



The interior

Soil sensors

Many of the more-recent dishwashers use multi-component soil sensors, which continually monitor the wash water during the wash cycle. These sensors help the dishwasher to wash for the amount of time that is appropriate for how dirty the dishes are, rather than for a pre-set period. When the water becomes clear enough, the sensor signals the timer to continue with the next cycle.

Door switch

Dishwashers have a door (or door interlock) switch that--if properly functioning--shuts off the dishwasher when the door is open.

Drying fan

Some dishwashers use a small fan to blow air (or heated air) into the dishwasher to dry the dishes faster. If your machine has a drying fan, it's beneath the dishwasher, usually in the back right corner.

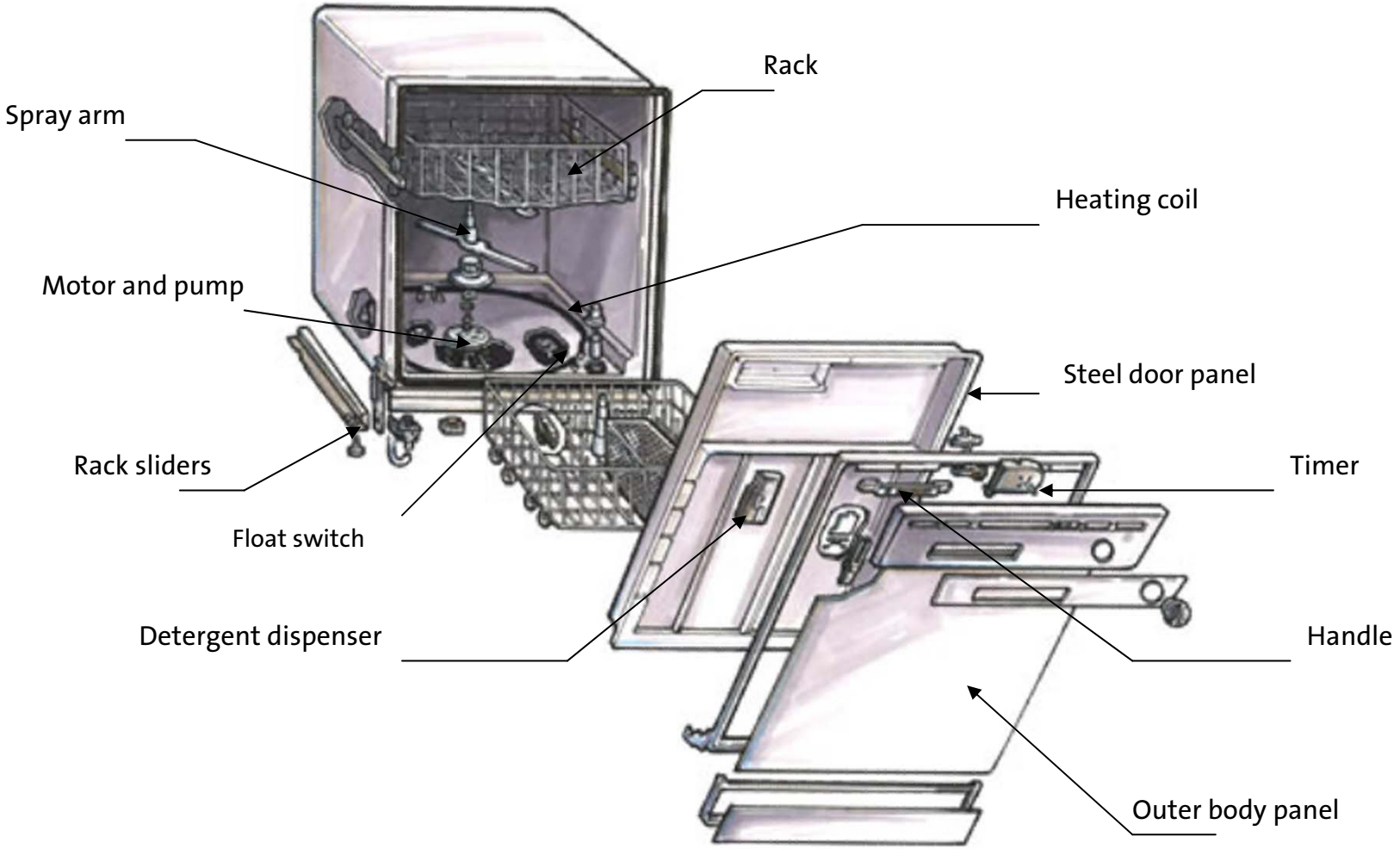
Heating element

Dishwashers have at least one heating element--which is often a circular black tube at the bottom of the dishwasher under the lower spray arm. The element usually assists in heating the wash and rinse water to the proper temperature and/or assists in drying the dishes. Some dishwashers have another heating element integrated with the drying fan, to warm the air blown into the dishwasher to dry the dishes.

The interior

The interior of a dishwasher is where the dishes go. It contains the dish racks, the spray arms, and/or the tower that sprays water at the dishes, the upper part of the pump assembly, and the water filter.

Various parts of the dishwasher



2 The journey from the West to India

Dishwasher as a concept is very western more suited for the western lifestyle and attitude. The amount of oil used in their food is less, there are no spices and masalas that burn and stick to the bottom of the vessels, milk is not boiled as it comes in ready to consume packets, and dinner plates are mostly chinaware or glass and not more than 10 inches in diameter. There is no concept of a katori or a waiti, and small dishes that are used in Indian homes for serving vegetables are not there. Everything is served in a single plate.

Moreover the kitchens are large and space is not an issue at all.
In India on the other hand.....everything is much elaborate. The dinner plates are large stainless steel 12 inch diameter ones with edges, there are katoris and small plates, and the cooking itself is so elaborate that it takes more than one vessel to cook a single dish. Then again the food habits vary considerable across the length and breadth of the country. Even the shape and the size of the vessels change and also the way they cook food.

And the biggest of all factors is the space constraint. And probably the only available space is taken up by the washing machine in the kitchen because there was not other place in the house to keep it.
No wonder then, that with such variety prevalent, and the lack of space, dishwashers have failed to fulfill the needs of all.

2.1 How do I then propose to tackle the problem??

The acceptance of alien ideas and objects into new cultures and its adoption is a steady and incremental process.

Prof. Athvankar

Let us first draw a parallel between the effect of various products that were of western in origin and become a daily object in the Indian context.
Cultures are never static but develop by assimilating ideas and objects by borrowing from other cultures. (Athavankar 1997 b) Assimilation process is typically complete when these objects are routinely used in daily life. For example, potato which is originally from Portugal is widely used in many different recipes and in many different ways across the nation. Not only that but Batata Vada, (Vada Pav) has even become the staple food of Bombay giving the city a unique identity.

The acceptance of alien ideas and objects into new cultures and its adoption is a steady and incremental process. New ideas or objects are accepted initially as an alternate experience, such as an occasional eating of exotic food (like Chinese or Thai food) Only some of these experiences get integrated into culture and become part of daily used objects.
But unlike consumables or food, appliances don't have the liberty to be tried once and discarded if not suitable. People take wise and informed decisions before buying anything new or unfamiliar. Not only that, they even spend a lot of time analyzing before buying something that has been in the market for a long time. Hence **for industrial products it is utmost necessary to prove its worth much before the consumer buys it.**

"It steams everything and it really gives a good feeling when you take those hot dishes out".

This is how the dishwasher will be successful

With the advent of the internet phenomenon, the world is shrinking fast. At least, for the user group that I'm targeting the product at. People are getting exposed to newer cultures, and lifestyles and adopting them fast. Cell phones, pizza places and the famous Mc Donald burger are all already pushing their way in. Look how washing clothes has become so simple these days with the washing machine which is a must have item these days. But clothes are more or less the same all over the world, at least the fabric is. Food is a different ball game. Well.....yes and no.
Let us take the example of an urban nuclear family. While I mentioned earlier that the cooking habits are varied and so are the vessels across the country, there are some striking similarities that are found in the urban setup

For one, everyone is becoming **health conscious.** And I not only mean the younger generation (which is exposed to the western lifestyle through media and the internet) which these days thrive on salads and half cooked, very less oily, cholesterol free and low calorie diet, but even the urban old who have been instructed by the doctor to reduce the intake of salt, spices and oils for health reasons. This is the very same reasons that the microwave ovens are finding a market for it is better to roast and bake than fry the food. And though the microwave is not used daily, the attitude is surely reflected in day to day cooking.
Hygiene has started playing an important role too. This too can be accredited to the health conscious new generation. It is not only what u intake but how u intake that matters. The one point that was repeated while doing my user survey with the dishwasher users was that "it steams everything and it really gives a good feeling when you take those hot dishes out".

A product does not remain a convenience if we are forced to change our habits so drastically in order to use it..

But some things will never change While we are culturally liberal, more in touch with the west, the **west will take a long time to touch us.** We will be thoroughbred Indians for a long time. And we will eat in steel thalis and have katoris and watis and pickles and ghee. So in some sense while we are lookin for convenience of cleaning dishes, we are not lookin forward to change the way we cook of the way we eat. Hell, it does not remain a convenience if we are forced to change our habits so drastically.
Hence the challenge is very intense. I have to design a product of convenience that has to deliver excellent results without demanding any sacrifice from the user.

Not only that, but I have to pitch the product against the **already existing design precedence.** By design precedence I mean a product or an entity that already exists in the market and is giving satisfactory results, in this case the maid, my most strong contender, cheap and convenient.
She is why the dishwashers have failed to make it big. Then again the existing dishwashers are directly borrowed form the west without altering or redesigning them for us Indians.
But then there are a few drawbacks with the existing maid system and there are some appealing advantages with the use of a dishwasher. **And the dishwasher will manage to come in if the drawbacks both of the maid and the existing dishwashers in the market are overcome and a viable solution to the problem is provided.**

3 Initial ideation

Before I started with the user survey I had a few ideas in my mind about devices that need not necessarily be a dishwasher in the actual sense bit instead a dish cleaning device of some other order.

For example I imagined an ultrasonic chamber in which vessels are loaded one after another at one end and clean dishes taken out at other.

Or instead a mechanical scrubber fitted to an electric motor by a flexible shaft that is placed over the sink. The idea was to reduce the manual labour involved in cleaning the dishes.

But the ultrasonic involved a lot of technology that would have had to be proven and hence the scope was limited. With the mechanical scrubber I thought it wouldn't have been a complete solution as manual involvement would still have been there as opposed to fill it, shut it, forget it, concept of the existing ones.

Hence challenge was taken to use the existing functioning of water spray jets which was rudimentary and well proven and develop it in a new and comprehensive design solution.

4 Survey

The survey was done in three parts. Product survey, to find the existing manufacturers in the market and the price they are selling it at, and the features they are offering

The second part was to find the requirements of a non dishwasher user and ascertain its need. To find out how he perceives it and if there is a need. It also included interviewing some maids and taking insights from them too.

A part of this survey was to study the activity analysis of washing by hand and find out how the vessles are cleaned, and how much detergent is used and how much effort is required.

The third part was to interview the dishwasher users and find out how they use it and if there are any problems that they encounter.

4.1 Product Survey

IFB

Zephyr

26,000

IFB

Neptune

21,500

Siemens

32,100

To begin with the Indian market was studied to find out which brands are available and the price. Also the common features were noted and the functioning of them was understood.

There are only two companies in India selling dishwashers, IFB and Siemens. The price ranges from 21,500 to 32,000 Rs. The siemens dishwasher is more costly because it is directly imported.

In terms of interior layout all are the same. The exterior finish and the cycle options vary and hence the price.

Analysis of the racks

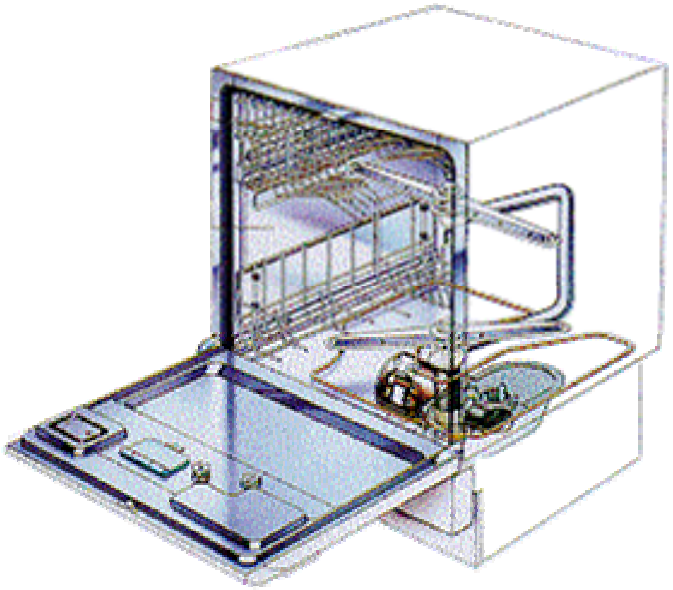
The interior comprises of two level of racks that have slots to place the dishes, and trays to place the bowls, cups and glasses. The tack comes out with the help of a slider for ease of loading and unloading, a feature that was adopted in my dishwasher too.

Generally the smaller items, like small plates and glasses are loaded on the upper rack and the bigger items like cooker, kadais and big pots and large plates are loaded on the lower rack. The silverware basket, to hold the spoons is a separate attachment loaded on the lower rack.

Arranging the vessels in the rack efficiently and correctly needs practice.

Analysis of spray arms

There are three levels of spray arms, the lowermost under the lower rack, the middle one under the upper rack that sprays water both on the lower and upper racks and a nozzle on the upper level that sprays water on top of the upper dishes. They are very efficient in terms of cleaning . They are self propelling, as in rotate themselves by the nozzle action and are not connected to the motor for rotation.



Good points that were adopted in the new design

Sliding racks

Stainless steel interiors

Silverware basket

Pulverizing filter

Door sealing

Analysis of detergent dispenser

The detergent dispenser is placed on the inner side of the door such that as the door opens the detergent can be loaded. The issue is that when the door is opened the dispenser goes on the ground level and one has to sit down to load the detergent.

Control panel

The control panel is on the outside of the door and has a cycle selector for mild, normal and heavy wash and a temperature switch that lets you select between 55 and 65 degree temperature setting.
Control panel is the one thing that distinguishes one model from the other.

Filter

There is a filter at the bottom of the dishwasher that pulverizes the waste in to small particles and drains I out with the water thus eliminating the need to clean the dishwasher after use.

Construction

Since all the models are flat under the counter type, the side and top panels are all flat made from folded sheet metal. Even the door panel, barring the control panel section is sheet metal
The interior if of stainless steel for rust proof and durability, an important feature.
The spray arms are made of plastic and so is the tubing.
The pump and motor, the heating coil and filters are all in the bottom section

Ergonomics

In order to load the dishes in the lower rack one had to bend over or sit down which is not a desirable position as one may have to keep getting up again and again to fetch the utensils from the sink.
The detergent loading as mentioned earlier is also cumbersome for this reason

4.2 User survey

User survey was done with both the dishwasher users, non users and the maids. Also the kitchen layouts, the various appliances that are kept in the kitchen, the kind of utensils that are used, and their quantity were studied.

Availability of space in the kitchen was carefully observed for it gave me key insights for designing my dishwasher.

Manual dishwashing
Insights from maids and housewives

•Maid washes quickly and is cheap. Comes once a day.
•Maid does not wipe dry the dishes.
•Common complaint is that maid uses more detergent and traces of it remain after washing
•Nearly 100 liters of water is consumed per wash
•4 kg of detergent or 3 vim bars are consumed every month.

•Maid never works at night.
•Utensils that are used at night are washed by the maid next day. Some do the night dishes themselves
•Dishes are most of the times pre rinsed and kept before the maid comes
•Tough to clean vessels of rice, milk and frying pans are soaked before cleaning.
•Hot water is never used.

•They think there is no space in the kitchen.
•Working couples find it inconvenient to keep a maid
•Those who do the dishes themselves at least once, want to have a dishwasher

Activity analysis

In order to find out if there are any advantages or disadvantages with hand washing the activity analysis of cleaning the dishes was done. Two housewives and two maids were video taped and later the videos analyzed to find out any hidden clues.

Activity analysis insights

•Lots of wastage of water, as it is kept running during washing.
• Running water rinses the other dishes in the sink
• Bai generally uses excessive detergents than the lady of the house.
• Tendency is to scrub and wash dishes in batches of two or three.
• She is in a hurry to complete the job at hand and move to a new house

• Bai can inspect dishes and if they are not clean can scrub them again.
• Wire scrubs are used to clean tava and kadai. They also need more application of force.
• Sink in the kitchen is always loaded with dishes.
•Milk vessels are scrapped with a spoon.
• Inside of glasses is difficult to scrub.

• Two large vessels are always there per washing.
•The smaller items like spoons and katoris and small plates are more tedious to wash than the larger items. This is an indication that priority must be given to smaller items than a few big ones in the dishwasher.

•Body language of the lady of the house reveals that she hates doing that chore.
•Feels tired and exhausted after the job is done
•It can take nearly an hour to finish all the dishes depending upon how many batches are washed together.

Dishwasher user survey

Insights from dishwasher users

On cleaning

• It cleans better than a maid. Good thing is that it steams everything and therefore kills germs.
•Even milk vessels and rice pots are cleaned.
•Don’t lose a single piece of crockery or even fragile glasses - so that's a big saving. Crockery comes out sparkling clean.
•They feel hygiene is a big factor. No maid can get close to this convenience.
•If maild does the dishes then some users steam them after that in the dishwasher

On Usability

•You have to rinse the dishes but then you often do that even for the maid lest numerous flies and bugs party around your kitchen.
•The current dishwasher is not suited for Indian vessels, eg. Plates with edges.
•Arranging the dishes is sometimes critical, and requires patience and practice.
•With a dishwasher, you also have the headache of loading and unloading it - with a maid, you don’t.
•Availability of detergent is not too smooth.
• One has more privacy around the house and lives to their own schedules.

On space and location

• If smartly placed under the kitchen countertop next to the sink - u load it immediately and your kitchen never looks dirty
•But the platform has to be broken to install the dishwasher under it. There is no standardization of platform height

Dishwashing needs

Variety/quantity of dishes per wash
(average family of four)

It is surprising to find out as to how many dishes can be there to clean per wash every day. Like I had mentioned earlier that since the cooking is very elaborate the no of vessels and spoons and katoris that we use just for cooking are substantial. Then there are the dishes used for serving along with glasses and teacups.

5 Product brief

User:

Middle class, lower middle class, earning an average of 15,000 Rs. Per month. This class of user is the one whose buying power has increased considerably in the recent past and aspires to have the conveniences of the richer class. He is though particular and very critical of the products he buys. Has inconvenience to keep a maid to do the dishes because of inconvenient working hours. Lives in an apartment with a small kitchen.

Capacity: (for a family of four)

Minimum

5 large plates
6 small plates
6 glasses
6 katoris
6 small bowls
cutlery
3 medium pots
pan

Vessels like cooker which are not washed daily are too big to accommodate in the dishwasher, and for its sake its size becomes big. For a 25% increase in space for just one vessel the cost of the dishwasher also goes up by 15 %. Hence, the suggestion to exclude them from washing in the dishwasher.

Usability:

•Placed next to or above the sink
•Should have ease in loading and unloading.
•Should have minimum manual involvement
•Dishwasher itself should be easy to clean; all parts should be easily accessible.
•Can act as a temporary storage so that sink area is clean.
•Controls should be ergonomically situated
•Even an illiterate maid, if need be should be able to use it.
•Should be easy to connect to the water inlet and drainage. (plug and play)
•In case of repairs should be easy to remove and install back.

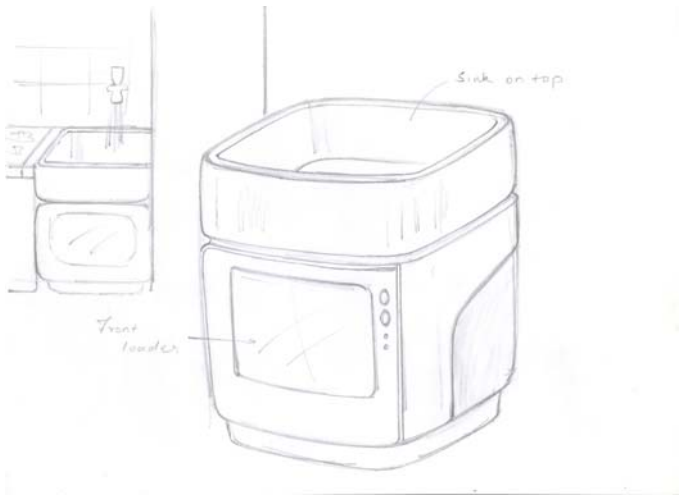
Health and Hygiene:

•Should communicate and should clean better than hand and **disinfect**.
This is important for the **dishes that are not heated** and are not used **for cooking** as bacterial growth is more likely to occur in these utensils. Also manual involvement for occurrence of contamination should be reduced.
•Should use less detergent and rinse the dishes properly.
No traces of powder should remain. Even though the chemicals available today are safe on hands, it is not guaranteed that they are harmless if consumed.

Form:

•Production cheap, but costly looking
•Stainless steel interiors for durability.
•Should communicate the way to use it on its own.
•Should be easy to maintain.
•Should have a costly hi-tech kitchen appliance look.

6 Concept generation



6.1 Hunt for space

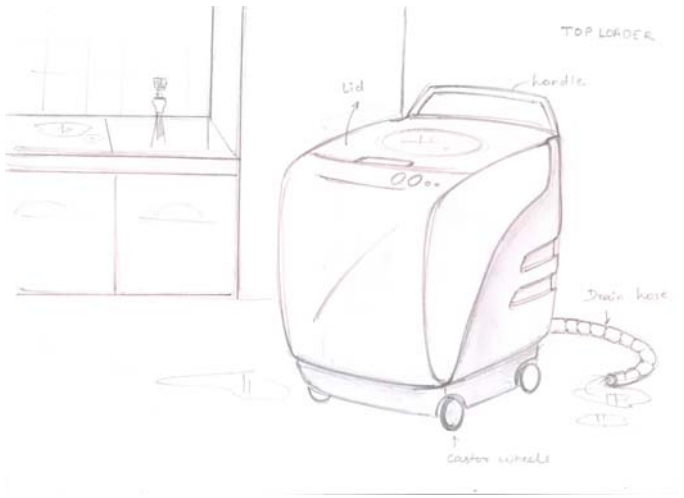
The biggest problem with buying a dishwasher in India is the lack of space to keep it. Neither are any standards followed while constructing the platform and hence it is impossible to fit the under the counter models under the platform without making any modifications. Also if one decides to keep the washer outside the counter then it is much of a hindrance and in many cases that space is taken up by the washing machine already.

So then how and where does one actually fit the dishwasher?

Carefully observing the space in the kitchen I found out that there are some corners which remain largely unused and can give me just that tiny window to squeeze in the dishwasher.

One is the space under the sink. It is never used for anything. Sometimes house cleaning detergents and a waste bin is kept under it which can easily be relocated. Hence I thought of a concept in which a dishwasher is designed with a sink on the top of it such that one removes the existing sink, and outs in this combo in its place.

Though this idea had potential it also had obvious drawbacks. No one I guess would have wanted to have a sink which is used to dispose waste water over a costly appliance. The combination of a waste collector and a cleaning device might not have worked in tandem.

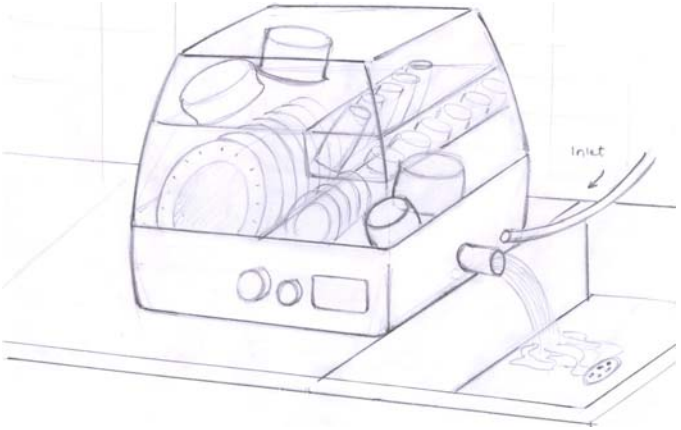


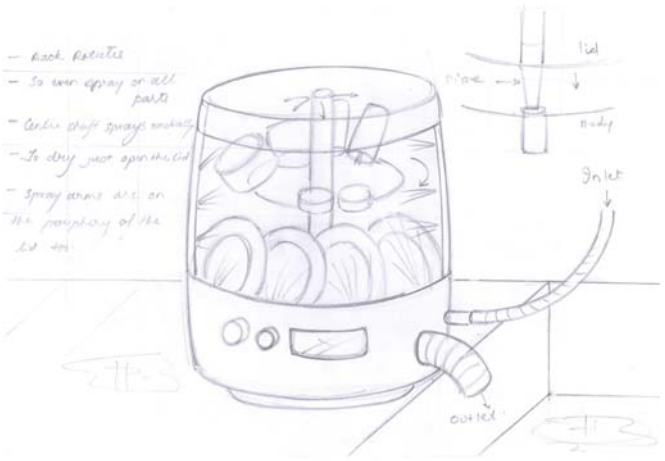
Then the other option is to design it like a portable machine on castors giving it the flexibility to be moved out of the kitchen when not needed. But then where would one move it, especially when the washing machine ends up being in the kitchen when it does not get a place any where else.

Then I thought of a place over the platform just next to the sink where usually the dishes are kept for drying after being washed. There is a good opportunity to use this place since it is not used for anything else but drying dishes. So came the concept of a counter top model.

The other area was on the wall right above the sink or next to it. The dishwasher would have had to be a flat one, like a steel rack commonly used in Indian homes, not projecting too out and hindering with the usable area of the sink. This concept demanded a radically new approach in terms of dish layout but had the most potential I thought.

6.2 Concepts for vessel configuration/arrangement for dishwasher





Category I – Over the Counter

The first idea that I worked on was the over the counter one for which inspiration was taken from the basket on which one keeps the dishes for drying. The basket itself is kept next to the sink. So I thought of a layout in which the dishes are orderly arranged and sprays from peripheries are used to clean them.

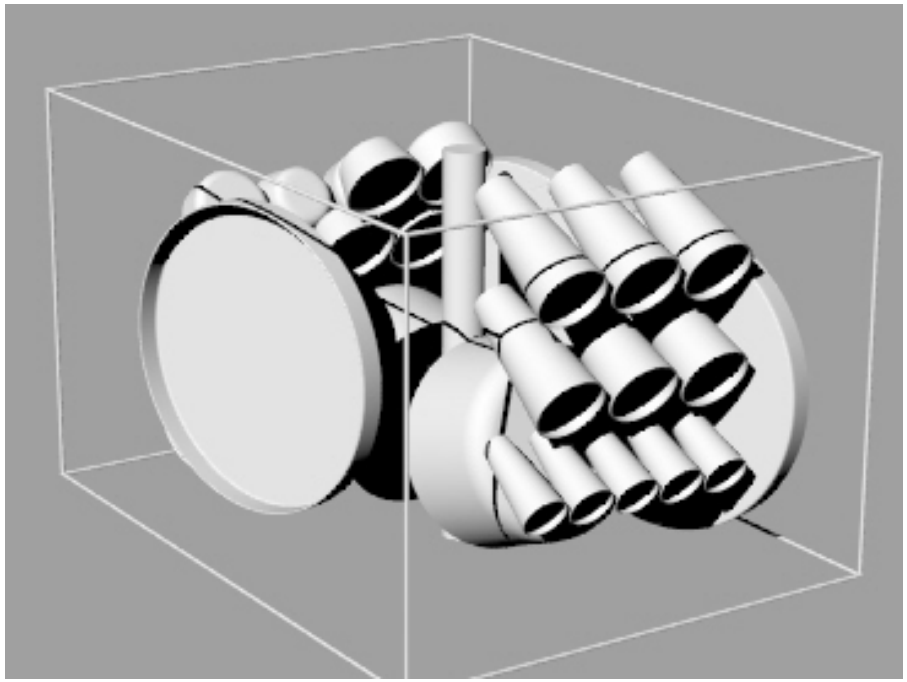
In the second idea I thought of a circular arrangement in which the dishes are pots are arranged on a circular rack that rotates around a central stationary spray tower which is spraying water radially outward and then there are sprays at the peripheries that are spraying water on the dishes radially inwards.

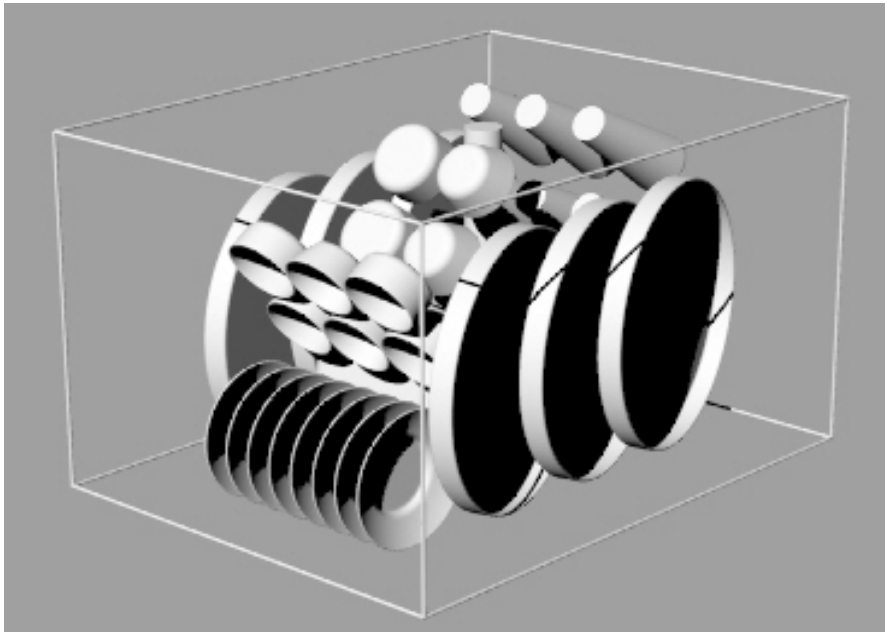
The second idea though would have required the dishwasher to be fairly of a larger diameter in order to accommodate all the vessels. Also the corner space on the kitchen platform was getting wasted because of this.
Hence it was abandoned and the first idea was developed further and the layout of the dishes was explored.

Advantages
No need to break anything to install
Could be placed near the water and drain source
Since it was at a suitable height, arranging the dishes was easier.

Disadvantages
Takes up platform space all the time, unless if made light enough to be placed elsewhere after use.
Complex arrangement of spray arms
Sealing would have been difficult.

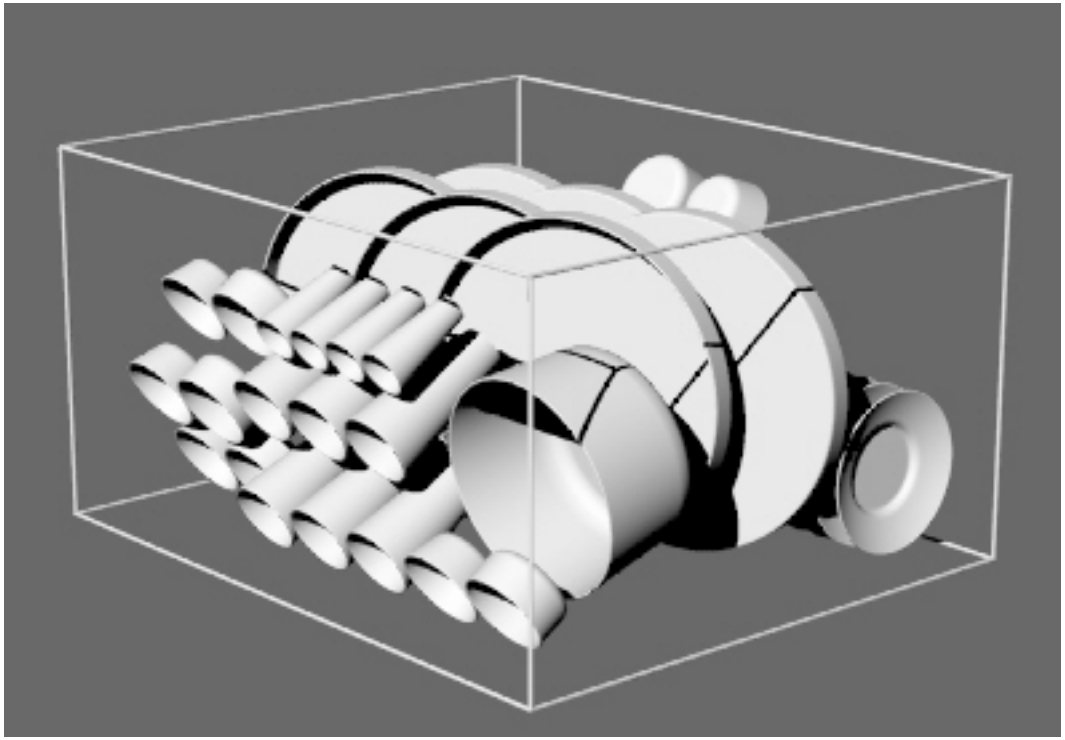
500 x 400 x 650 (W x D x H)



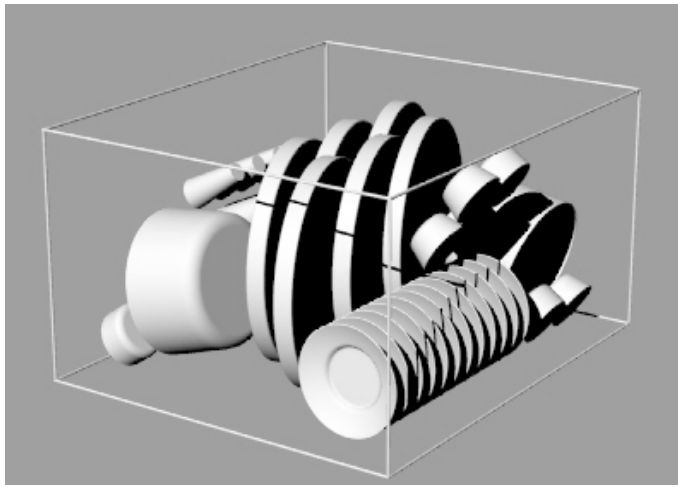


Category I - concept I (vessel arrangement)

In the first layout of dishes for over the counter concept, the larger plates are arranged outside, and the pots on the inside. There is a central spray tower. The pots and katoris in the vicinity of the towers are facing toward the central shaft, and the plates and glasses are facing the periphery. The drawback is that the outer large plates will block most of the peripheral sprays and prevent them from reaching the interiors.



550 x 350 x 650 (W x D x H)



Category I - concept 2 (vessel arrangement)

In the second layout the large plates were placed in the centre facing the periphery with smaller katoris and glasses arranged at the edges. The central tower was removed as in this layout owing to the graded arrangement by size the sprays could reach the centre. Also the dishes were arranged in a manner by which they faced only two sides of the dishwasher for better orientation and ease in arranging.

Category II – Flat against the wall (vessel arrangement)

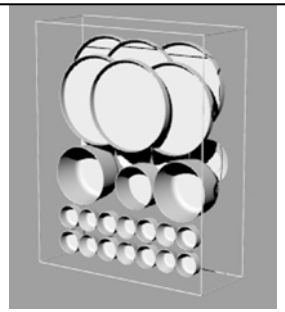
In this type the dishes were arranged flat against the wall, all facing one side, the side of the spray arm and the door for loading the vessels was on the opposite side. The large plates were on the top level, with the small plates and pots occupying the middle level and the katoris down at the bottom.

Advantages

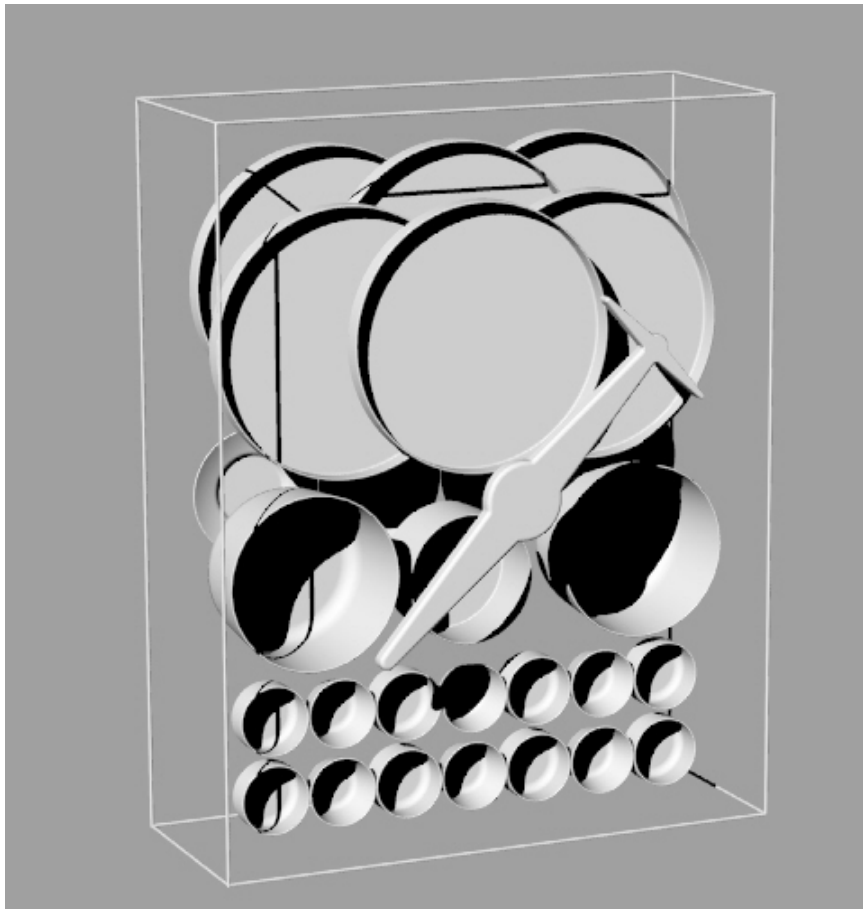
No need to break anything to install
Could be placed near the water and drain source i.e. above or near the sink
Since it was at a suitable height, arranging the dishes was easier.

Disadvantages

Due to flatness the volume would have to be compensated by increasing its length and breadth
Clear area would have to be kept for the door opening
Might interfere with the sink area



660 x 830 x 250 (W x D x H)



Category II - Concept I (vessel arrangement)

This was the initial arrangement, rather crude but then had more potential than the concept type I in terms of arrangement of dishes, ease of loading and usability. Also the platform space would have been saved cause this one went on the wall as a permanent fix.

Advantages

The door closing and sealing detailing would have been the same as the existing dishwashers which was tested and proven

Takes no effective space

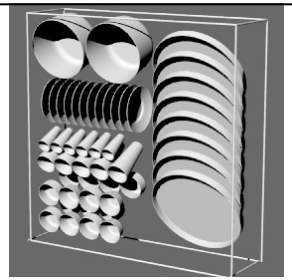
Loading the dishes is easier, can be compared to loading dishes on the steel racks.

Disadvantages

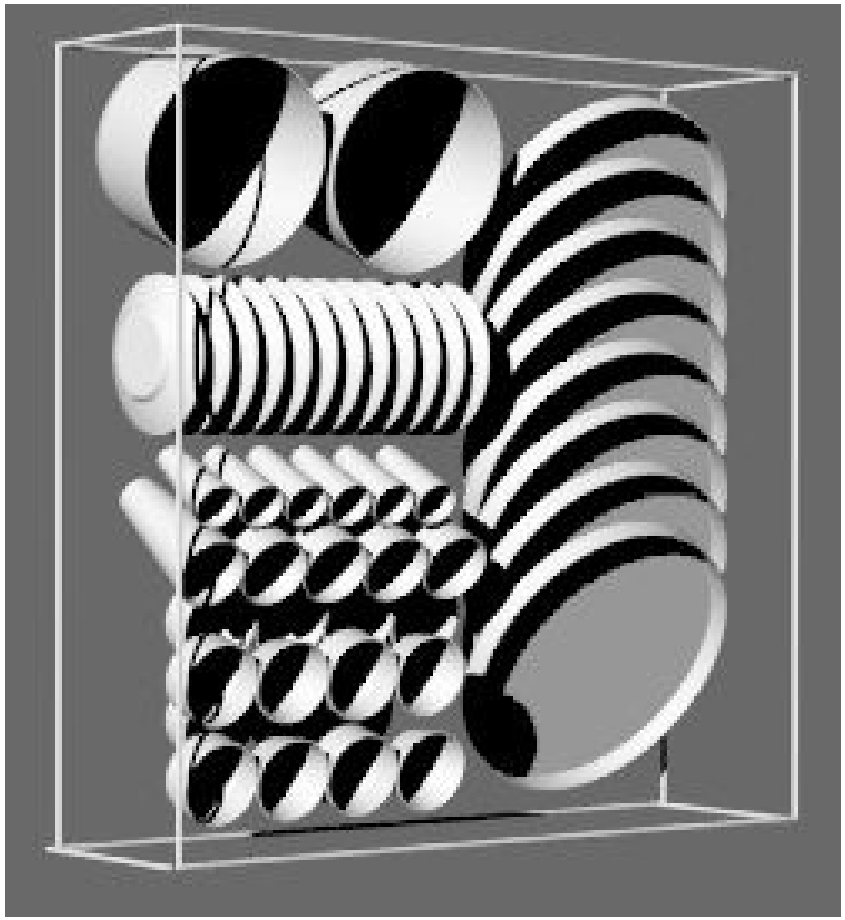
Since it was flat, size in terms of its length and breadth is very large.

The rear plates were less exposed than the front ones.

The top level could be out of reach of the 5th %tile woman.



750 x 750 x 200 (W x D x H)



Category II - concept 2 (vessel arrangement)

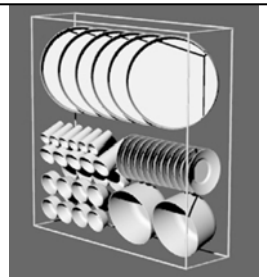
The layout was such that the arrangement was split into two halves. large plates were arranged on one side facing downward so that water runs out easily from over the dishes. On the other side the larger pots were pushed to the top level and the smaller items like katoris and glasses which are large in no are arranged on the lower levels as the activity of loading these items will take more time and effort than the big vessels that are few in no. There were two layers of katoris, one behind the other with gaps in between through which the sprays reached the back katoris. The small plates were located at the upper middle level.

Advantages

are that owing to the downward facing of plates water will drain easily.
Ease in loading the katoris.
Spray reachability in all corners is adequate.

Disadvantages

Since the pots are at higher level, then if there smaller pots in larger no. arranging them will be difficult at that level.
The orientation of the plates is not easy to construct a rack around either.
No of vessels that can be washed are less.



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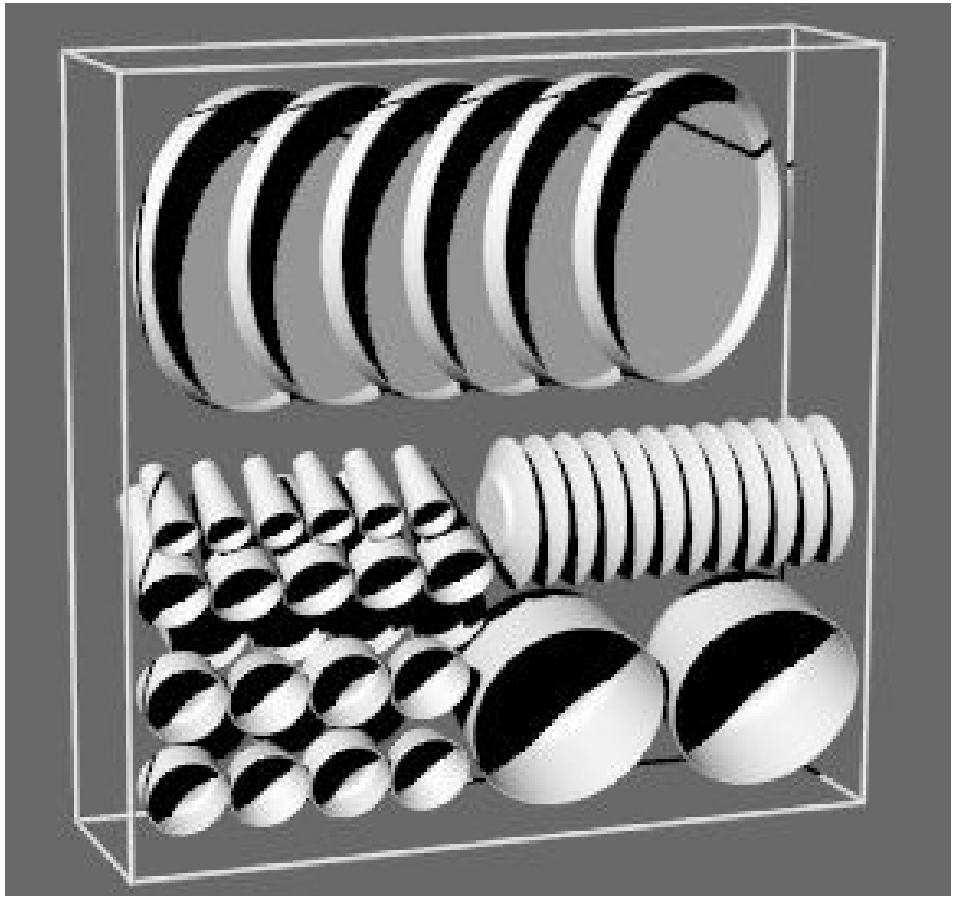


Category II - concept 3 (vessel arrangement)

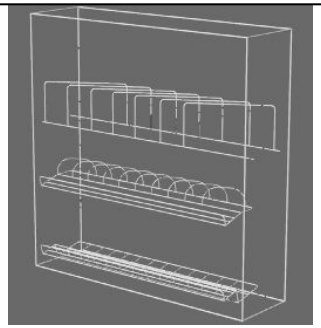
In this arrangement again the layout was divided in to halves, but horizontally. The plates went to the top level and were inclined such that adequate spray reached the surfaces even in case of edged plates. It was easier to load the plates too this way as it was similar to the manner in which it is loaded on the steel racks. The lower level was divided into left and right sections in which the glasses and katoris in multiple layers were loaded on one side and the smaller edgeless plates and vessels were loaded on the other side. This layout divided the entire arrangement in to distinct sections.

Advantages

Loading the plates is easier
Washes the same no of items as the previous layout but the height and hence the size is greatly reduced.
Spray reachability in all corners is adequate.

Disadvantages

In this arrangement too, the no of pots that can be washed are less.



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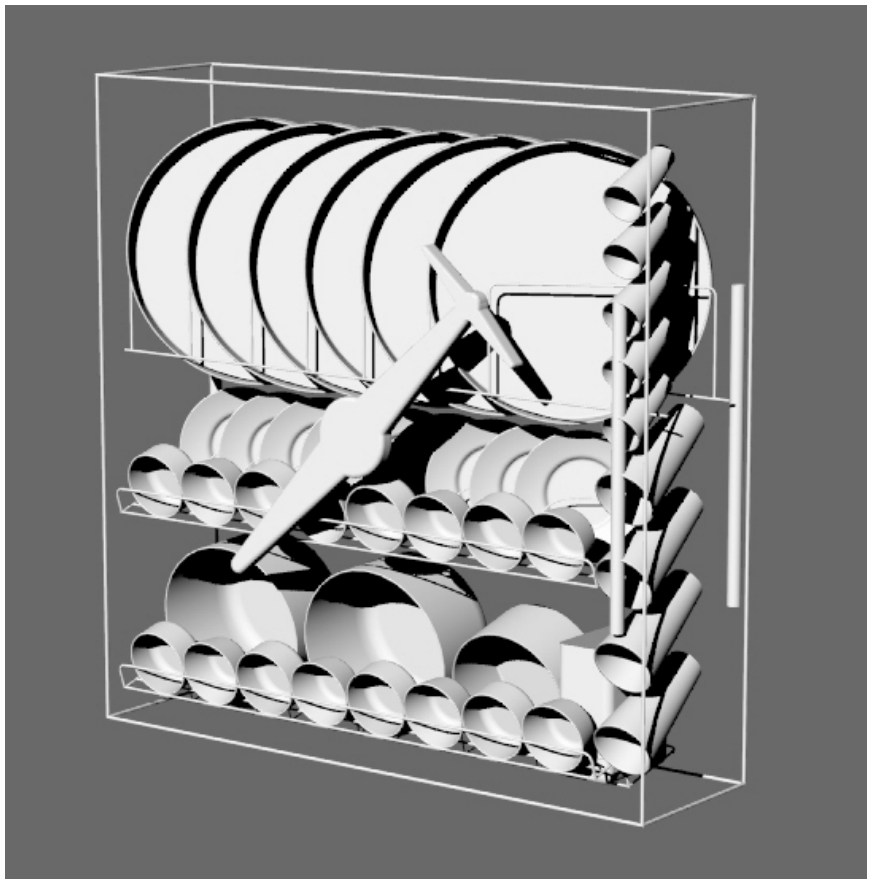


Category II - concept 4 (vessel arrangement)

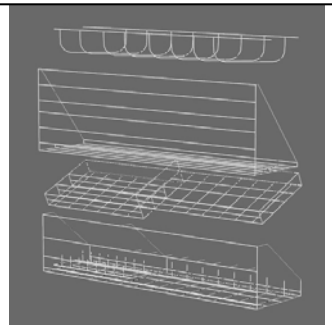
In order to overcome the drawback of less no of pots, this arrangement was designed. The plates remained at the top, but the lower level was given to the pots. And the katoris were distributed in those tiny spaces in front of the small dishes in the middle row and in front of the pots in the lower row. The glasses were put near the side thus making use of all the available space more efficiently. Though there remained no clear demarcation of the interior space for the katoris which were distributed in two different rows, the arrangement was by far the most efficient if not most organized.

Advantages

Efficient use of interior space.
All vessels exposed sufficiently for better cleaning
The most compact size
Ease of loading the dishes.

Disadvantages

Interchangeability is not there.
Glasses are loosely arranged.
Vessels of a kind are not grouped well together.



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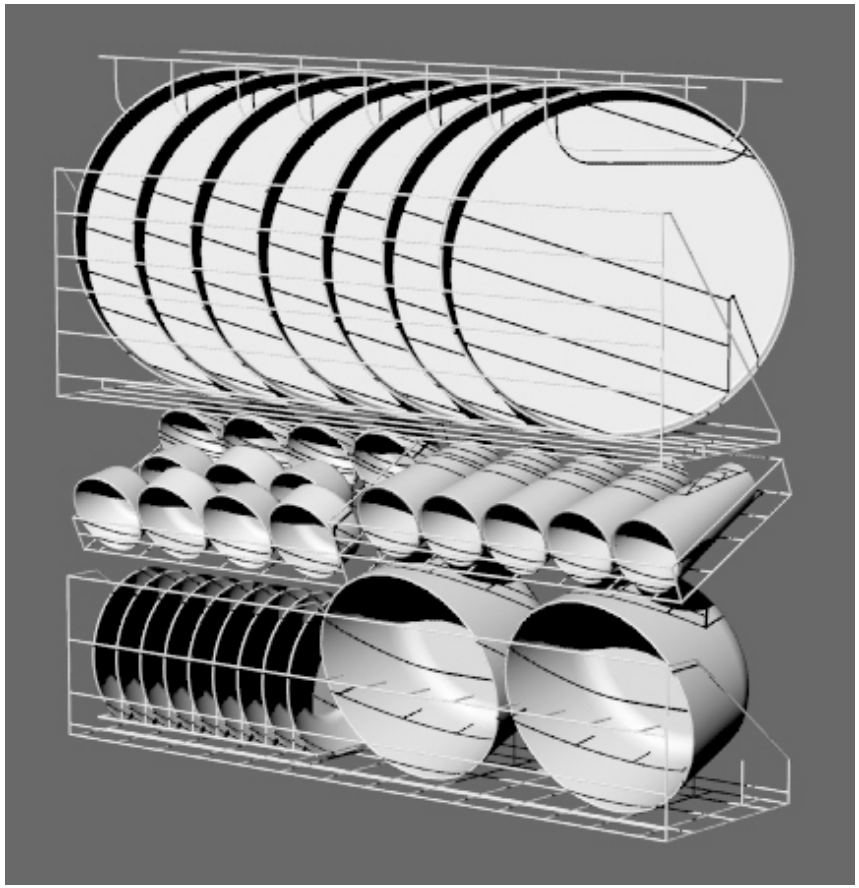


Category II - concept 5 (vessel arrangement)

In an effort to have a clear demarcation for the vessels of a kind I thought of again shuffling some of the utensils. Also I thought that the glasses in the previous arrangement were a bit loosely arranged. Also at this level I thought of interchangeability as a important feature.

By interchangeability I mean an option to load large pots in place of plates, or to load smaller plates in place of the small pots and vice versa. This I thought would be the greatest asset as the requirements of kinds of dishes from family to family were subject to change.

Hence a new layout with a more detailed and flexible natured rack system was designed as shown in the figure.

In place of the six inch plates in the left corner can be loaded small bowls and now where the pots are, large plates can be loaded. Also in place of the large 12” plates wide pan or pot can be loaded, as always so many plates might not be there for washing.`

6.3 Evaluation of vessel arrangement / configuration

At this stage it was imperative that some direction was freezed on the layout of the dishes or else the exploration would have been endless. What was now needed was a more vertical approach to refine the arrangement, hence the existing layouts were compared and evaluated.

Evaluation criteria

The comparison is done on parameters like size, ease of loading, spray arm reach, interchangeability, variety of vessels washed and grouping pf vessels.

Each evaluation parameter is given different weightage according to its importance and each concept has been given a rating out of 5 for each parameter.

Eg. Example type II concept 3 had got rating 3.5 for ease of loading and unloading and the weightage for that parameter is 8, so 3.5*8=28 and similarly all the points of all the parameters were summed up.

Then the total was divided by the sum of weightages. Ex for Type II C 3 the sum is 123 and the sum of weightages is 44. hence, 123/44=2.975.

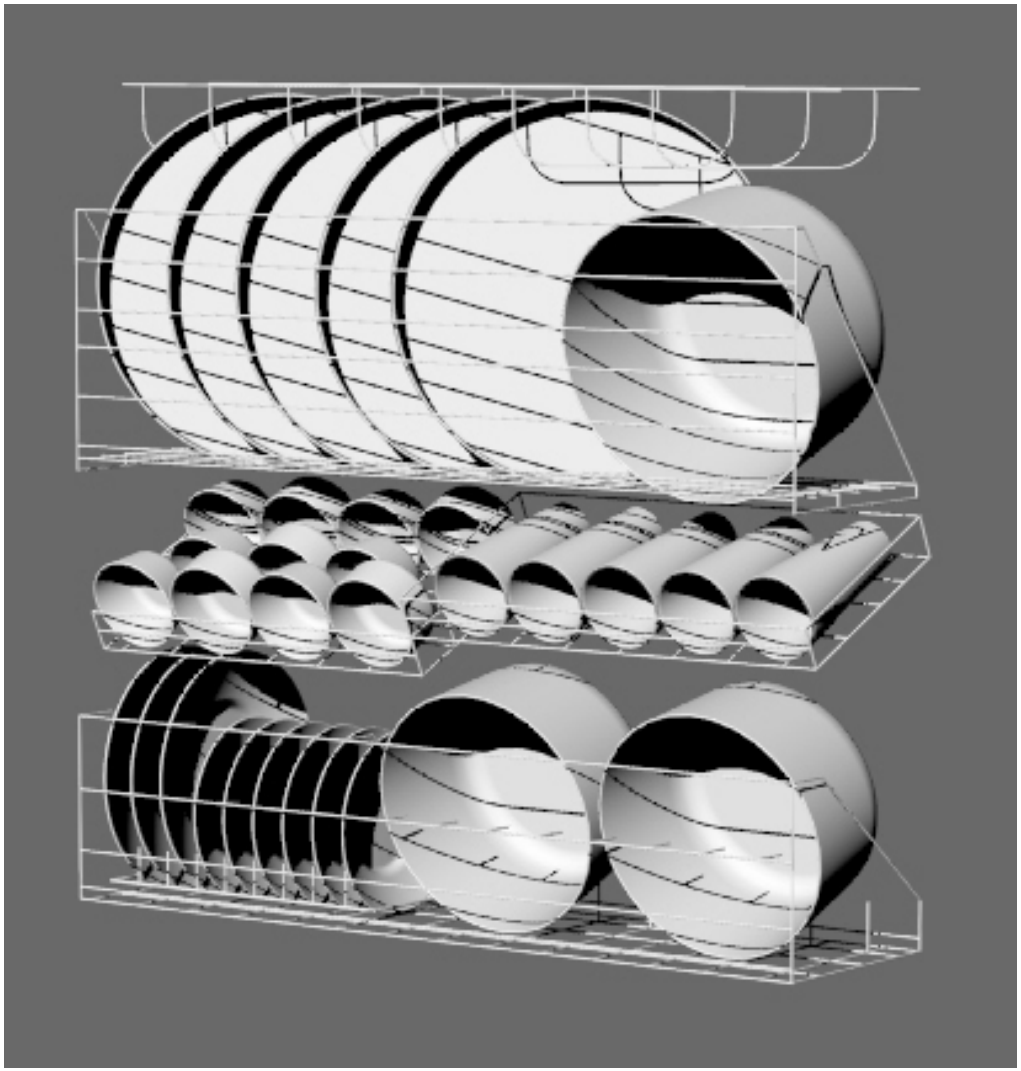
Similarly the ratings for all were calculated.

It is seen that type II concept 5 is scoring the most. Hence it was selected for further refinement.

Evaluation chart

	Category I C 1	Category I C2	Category II C1	Category II C2	Category II C3	Category II C4	Category II C5
size (10)	2.5	2.5	1	1	3	3	3.5
Spray arm reach (8)	2	2.5	3.5	3	3.5	3.5	4
Ease of loading and unloading (8)	1	1	2	2	3.5	3.5	3.5
variety and no. of vessels washed (7)	3	3	2	3	3	3.5	3
Grouping of vessels(4)	4	4	4	4	4	2	4
Total	86	90	91	87	123	118.5	132
Rating	1.954	2.045	2.068	1.977	2.975	2.681	3.000

The category II concept 5 scored the maximum and hence was selected for further refinement

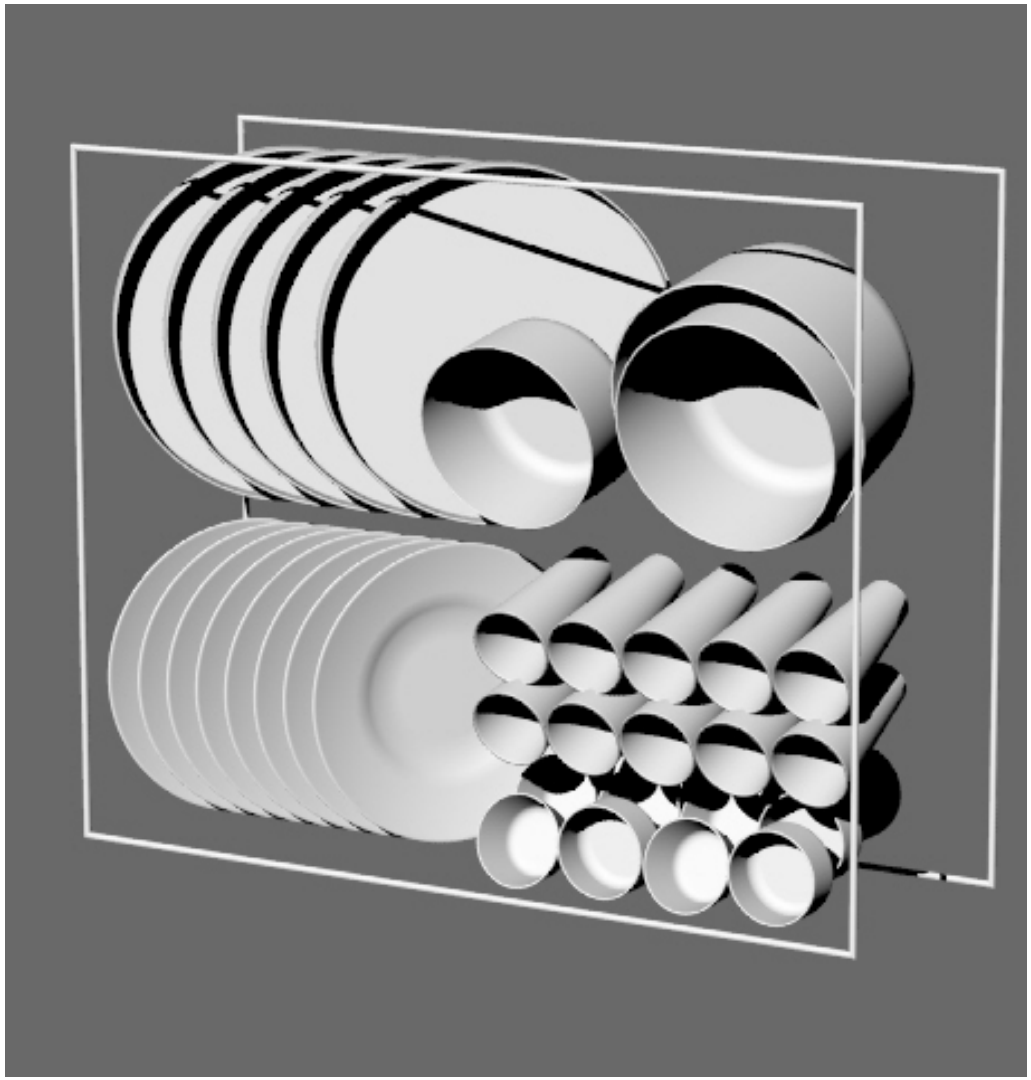


Iteration 1

After the layout was selected, I got to the task of putting it to test. In some sense the lateral thinking part was over. Now I wanted to dwell deep and improve the chosen layout further.

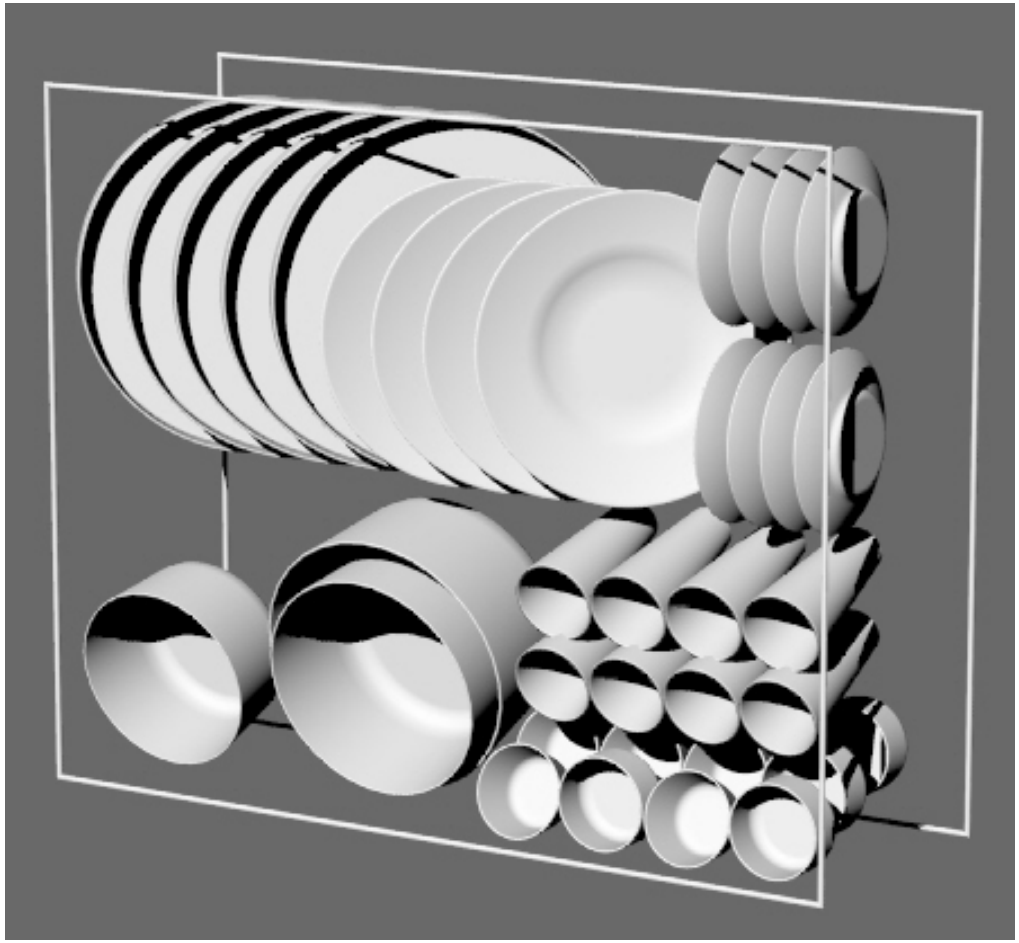
The first thing I did was I increased the height a bit so as to accommodate the 8” plates along with the 6” ones. The 8” plates were otherwise had to be put instead of the pots and that was not desirable.

The new layout though not substantially different, did take care of the all important flexibility in design issue and also opened up a big door for further speculation.



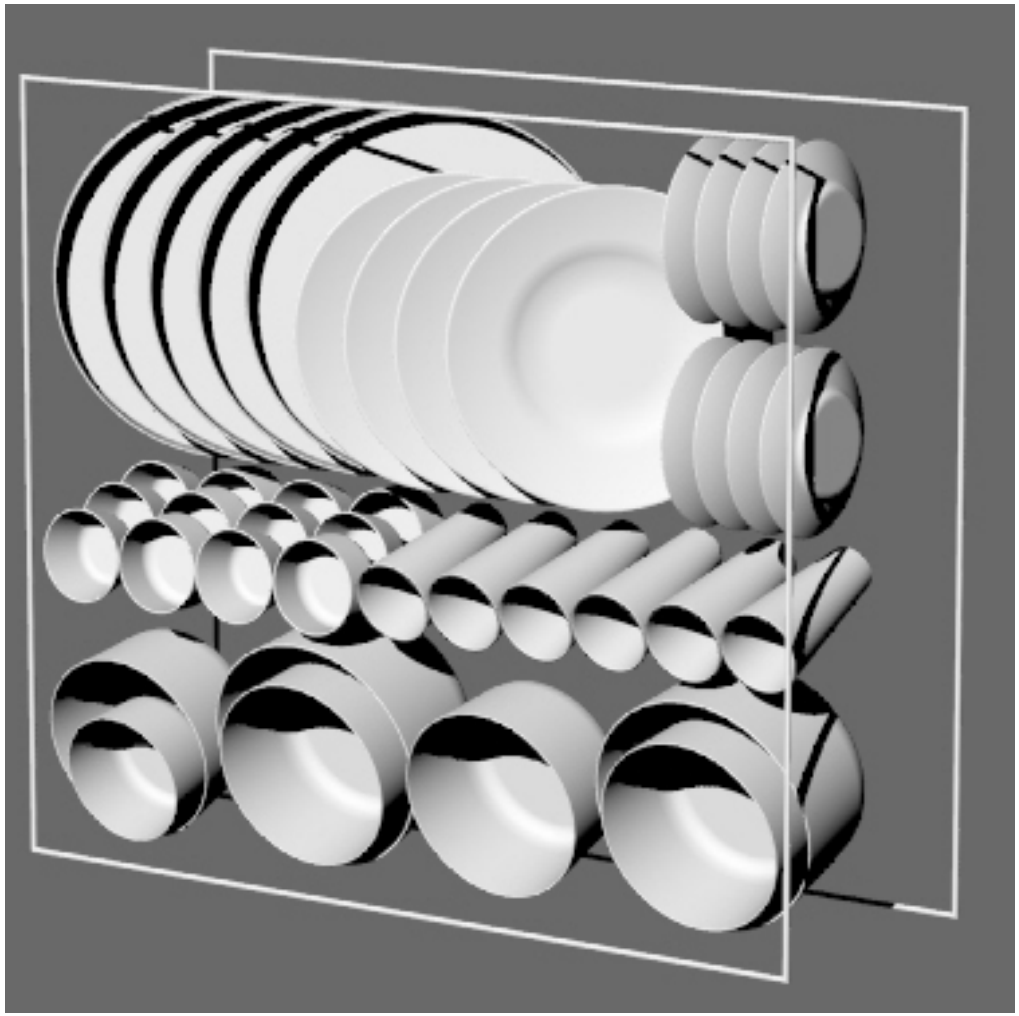
Iteration 2

The next attempt was a rather bold move. I tried to include the 10” plates too in the lower rack and shifted the pots on the upper level along with the large plates. In doing so I was able to arrange the top plates even more compactly which saved on a lot of space. This was a good option that became the benchmark for further iterations. I also shifted the katoris and the glasses together on one side. The idea was to reduce the height even more.



Iteration 3

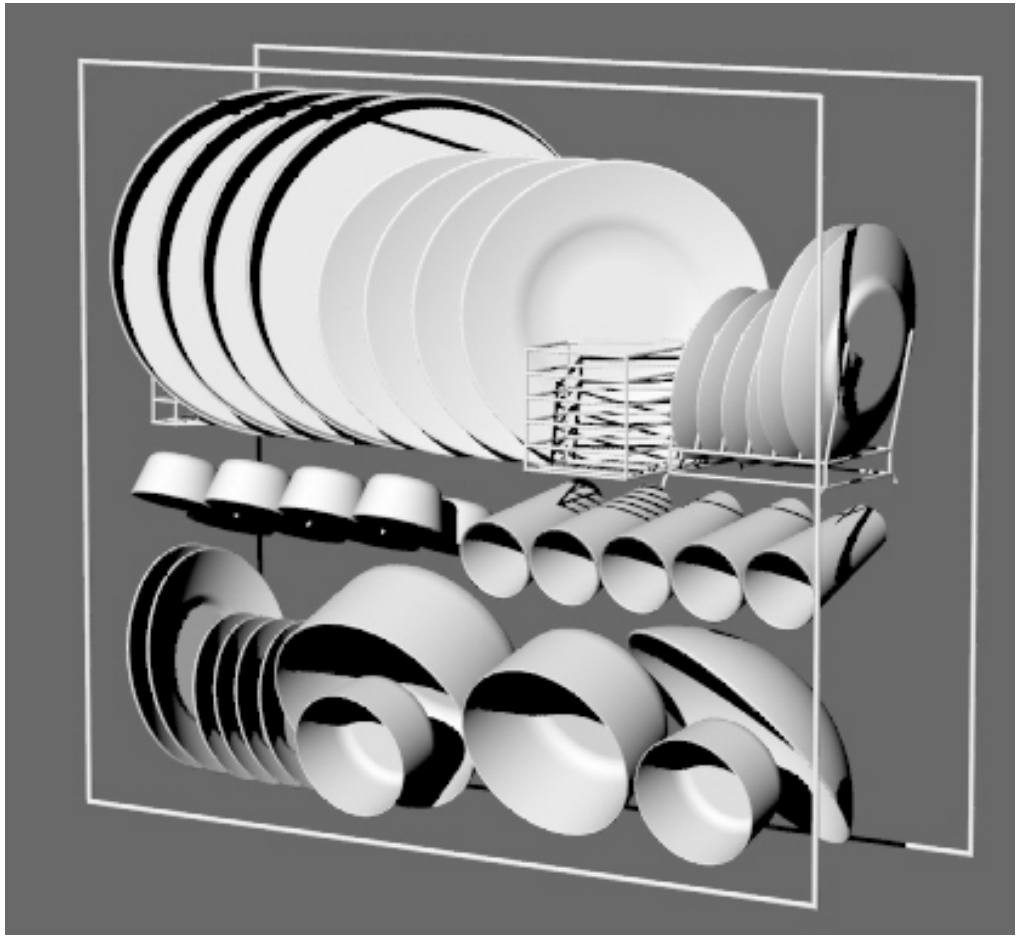
I thought arranging the pots on the upper level would have been difficult. Hence I shifted them back on the lower rack in place of the medium plates, which I shifted up. I also reduced the no of large plates and medium plates from 13 to 9 and accommodated 8 small 6” plates on the upper rack too. The reasoning was again that arranging the plates in slotted racks was simpler at that height than pots.
In this layout I was able to squeeze all size plates on the upper level, thus increasing the compactness even more.`

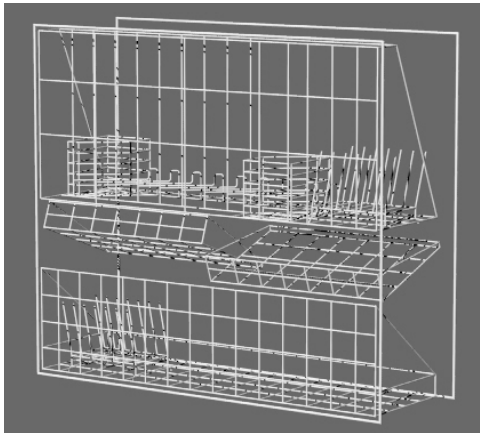


Iteration 4

While making the next iteration I was in a bit of a dilemma. If I would just increase the height of the layout by just 100 mm and rearranging the katoris and glasses in the middle level, I would have been able to have a lot of pots on the lower racks. But the increase in the height was critical, as I did not want the dishwasher to be out of reach of the 5th %tile woman. But then I thought that I had to take that chance cause it was increasing the capacity of the dishwasher for the pots very much and that was more critical to sell it to all %tile people.

750 x 600 x 200 (W x D x H)

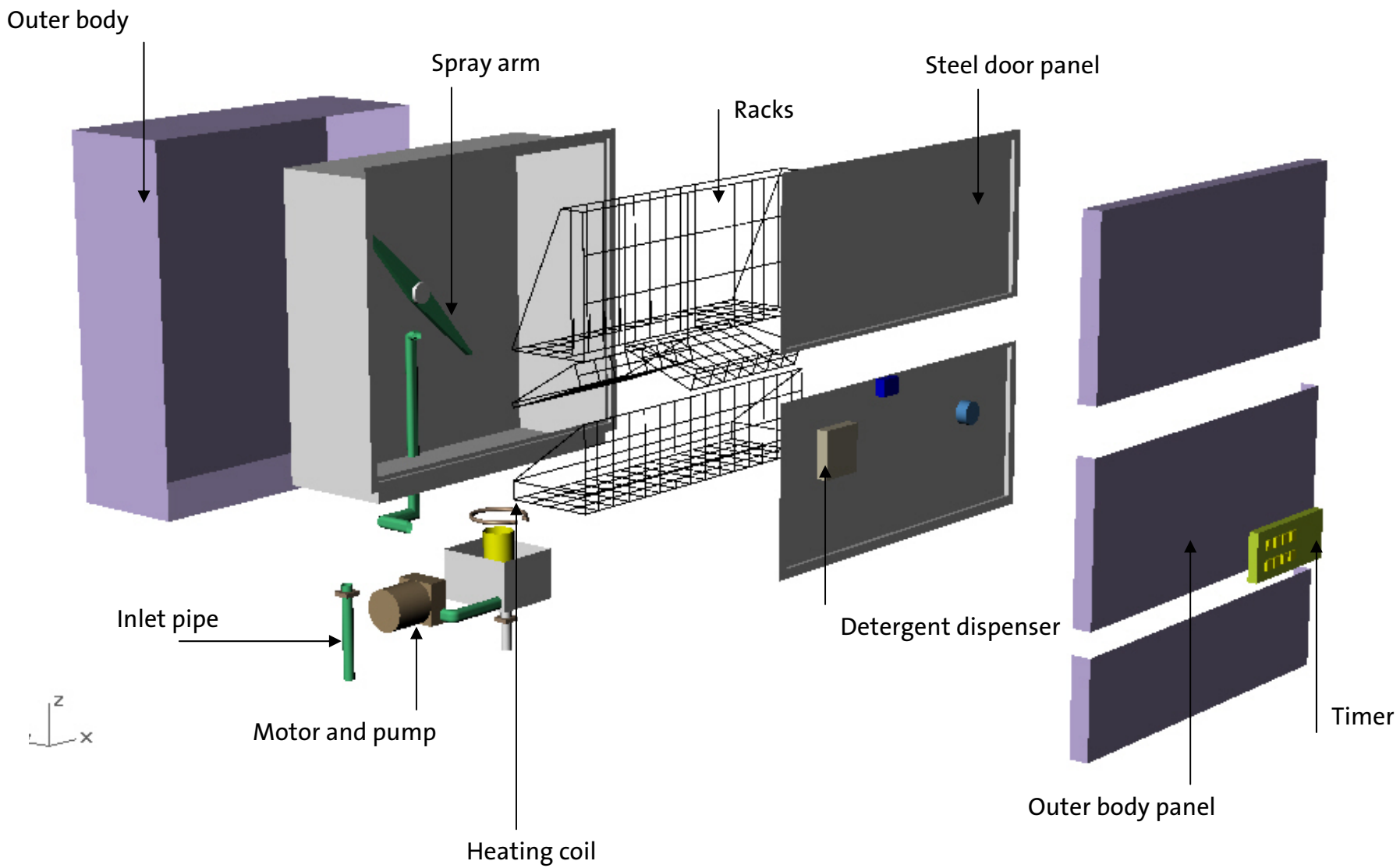




Iteration 5 : The final one

The last and final iteration was changing the way the katoris were kept. It was always going to be simple to place the katoris face down, than on its side wall. Hence I divided the middle rack in two sections, which were pivoted at a point. If glasses had to be kept then they would rest on their side wall, as because of their length they would rest easily. Katoris would have toppled unless secured. But for the katoris to be put face down, the rack had to be tilted in order to let the spray in. hence the tilt was given. It was kept flexible such that instead of glasses, more katoris could be loaded on the other rack too depending on the no and priority of katoris and the orientation changed.

Exploded view of proposed design concept



7 Product Semantics

After the functional considerations were addressed and a final layout chosen, came the challenge to design or give a form to the product. In many was I thought the tricky part was over and all that remained was to design a shell. How greatly I was proven wrong.

The issues dealing with the form for this project were far from being simple. The user requirements and the functional issues and space constraints had taken me so away from the existing dishwasher layout that I had to find a way back in some sense to bring the dishwasherness into the product. Or did I? At this starting point I took the liberty to break away from the norms and experiment with the form albeit cautiously but also radically.

With the functional layer in place the product form as I see it was going to form the communication layer. How well I communicate the idea of a dishwasher was going to determine the success of my design.

It is interesting to note that visual clues have a key role to play in developing links with stored experiences. People in India have already been greatly exposed to the way a fridge looks or the way a washing machine looks and have already formed a certain mental imagery of these products. As far as a dishwasher is concerned, owing to the lack of any successful product in the market a large no of people are greatly unaware of the way a dishwasher looks and I suspect don't have a strong mental imagery. Hence the visual clues for a dishwasher were scarce. Also as I mentioned earlier the functional requirements had taken me away from the dishwasherness.

But a product should not loose its links with the primary object category. Care I thought would have to be taken to keep the product well within the semantic space of the dishwasher category. But then what was this category. In India the dishwasher category did not even fully exist. So may be I had to even define this category in a way.

For that I subdivided the product in three different levels
Primary category - Expression of a kitchen appliance
Secondary category - Compactness
Dishwasherness
Partner concepts - Expression of status

By varying the weightage of every category, and by a lot of permutations and combinations I was in a position to generate a lot of concepts. Related products like refrigerators and washing machines were also looked at for borrowing some visual clues.

All said and done though, I was drawn to have a rather bold departure from the dishwasherness just to find out for myself if it can work. Any way the functional and economic benefits were more striking for the layout that I had finalized and were prompting me to have a certain amount of radical shift.

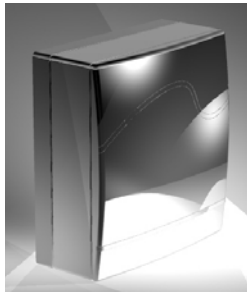
8 Form generation

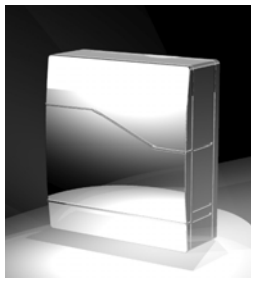
The functional considerations had fixed up the dimension of the form roughly, though certain modifications were happening all along, varying the dimensions of the layout. This can be seen in the slight change in the dimension of the form as we progress.

Form, the way it looks and the way it interacts with the user was going to determine the product category that I mentioned earlier. A lot of concepts were done and a lot of ideas tried out. I have tried to group them in to four categories for purpose of classification and evaluation. The classification was done on the basis of door layout, as in the way it opens, and weather or not it has a window.

The first category comprises of the single door opening on one side
The second category is that of single door opening on one side with a window.
The third of a single door that can be made to open on either side depending on the location
The fourth of a vertically split door in the middle,
And the fifth of a horizontally split door

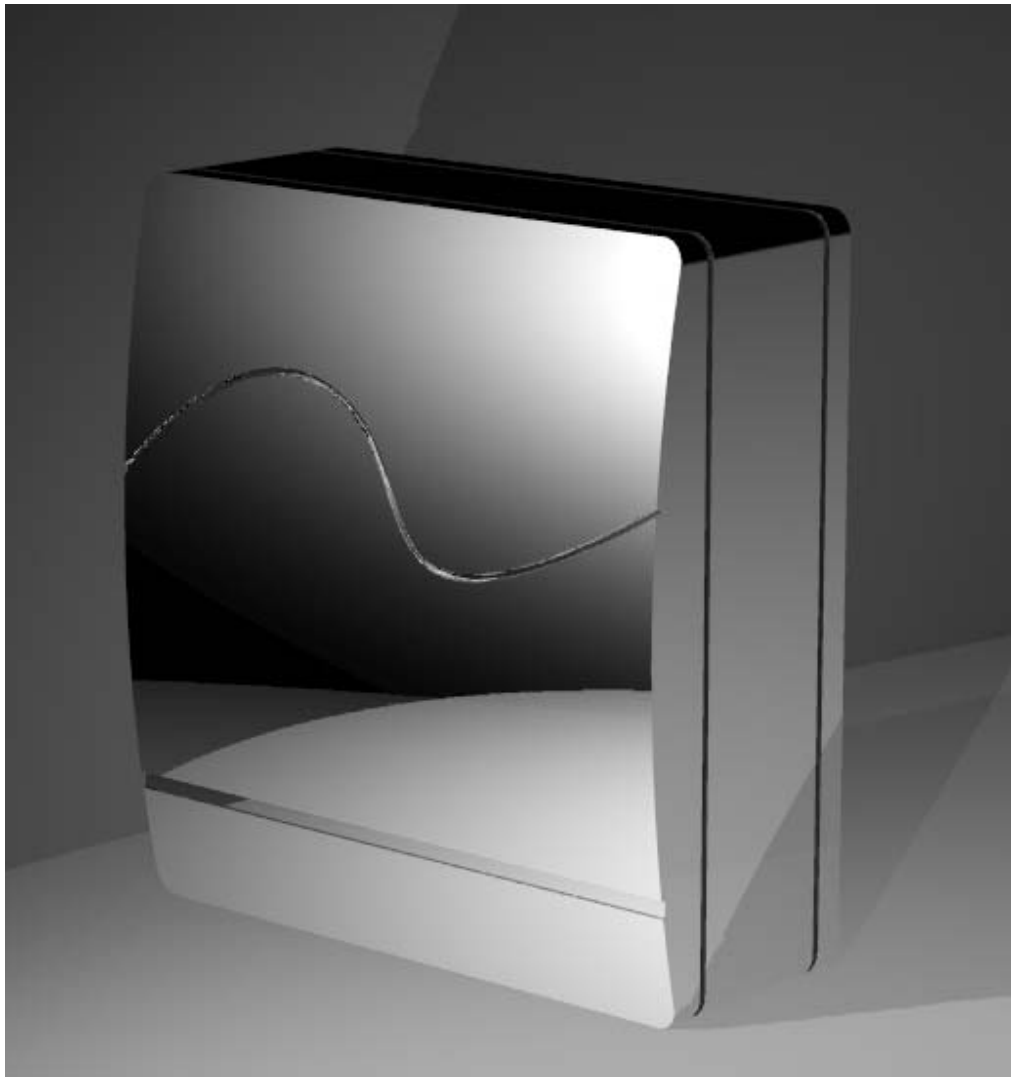
Various concepts of each kind were made and formally analyzed. It must be noted that work on all the categories was not done all at one time and it was more of a linear process. The drawbacks that were found were addressed as the next category was dealt.
Each category had its unique good points and bad. But the fifth category is in some sorts an amalgamation of all the good points that were offered across the categories.





Form generation
Category I : Single door opening on one side.

The expensiveness had to come, the dishwasherness had to be defined and then there had to be that look of a kitchen appliance. The inspiration was sought from the stainless steel appliances like big ovens and the new brushed stainless steel finished refrigerators that are coming in the market.

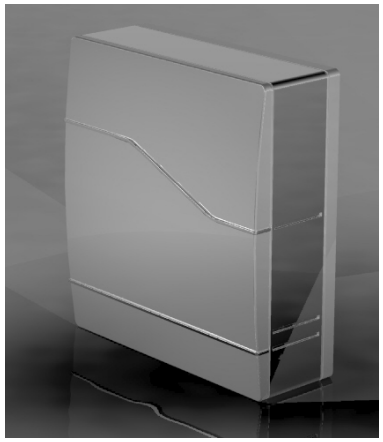


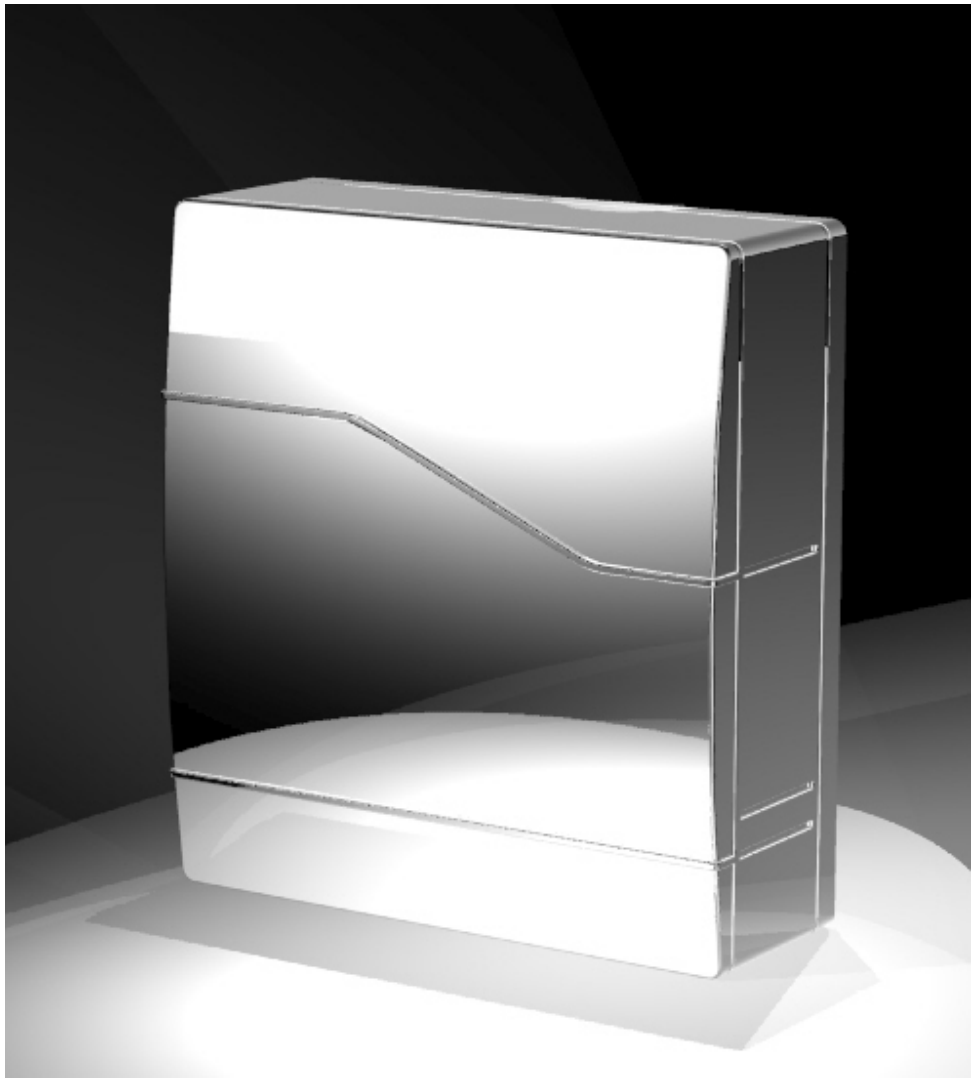
Explorations

The attempt was to keep the face clean and uncluttered, with no sudden clashing surfaces or lines. Sort of classy, an expression of a sleek hi-tech appliance. Also the grooves on the surface I thought would play a very pivotal role in look of the product. But then the care had to be taken so as not to overdo it. At a size that I was targeting, the chances of it going wrong was high.

The door shut line was made prominent and an additional groove on the side panel to demarcate the section of the spray arms was added. This was to visually give the indication of how it was inside and also compliment the door shut line.

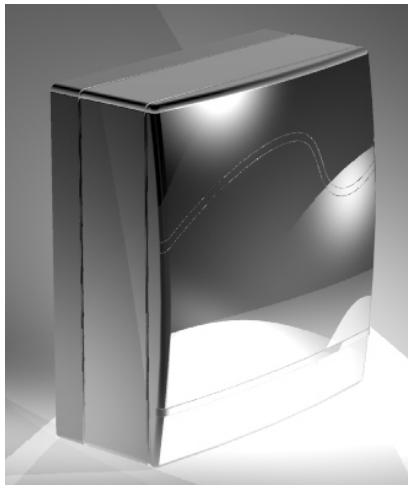
One more groove, a straight line on the bottom of the door was added to indicate the lower pump and heater housing. A curved groove on the top balanced out the entire look.





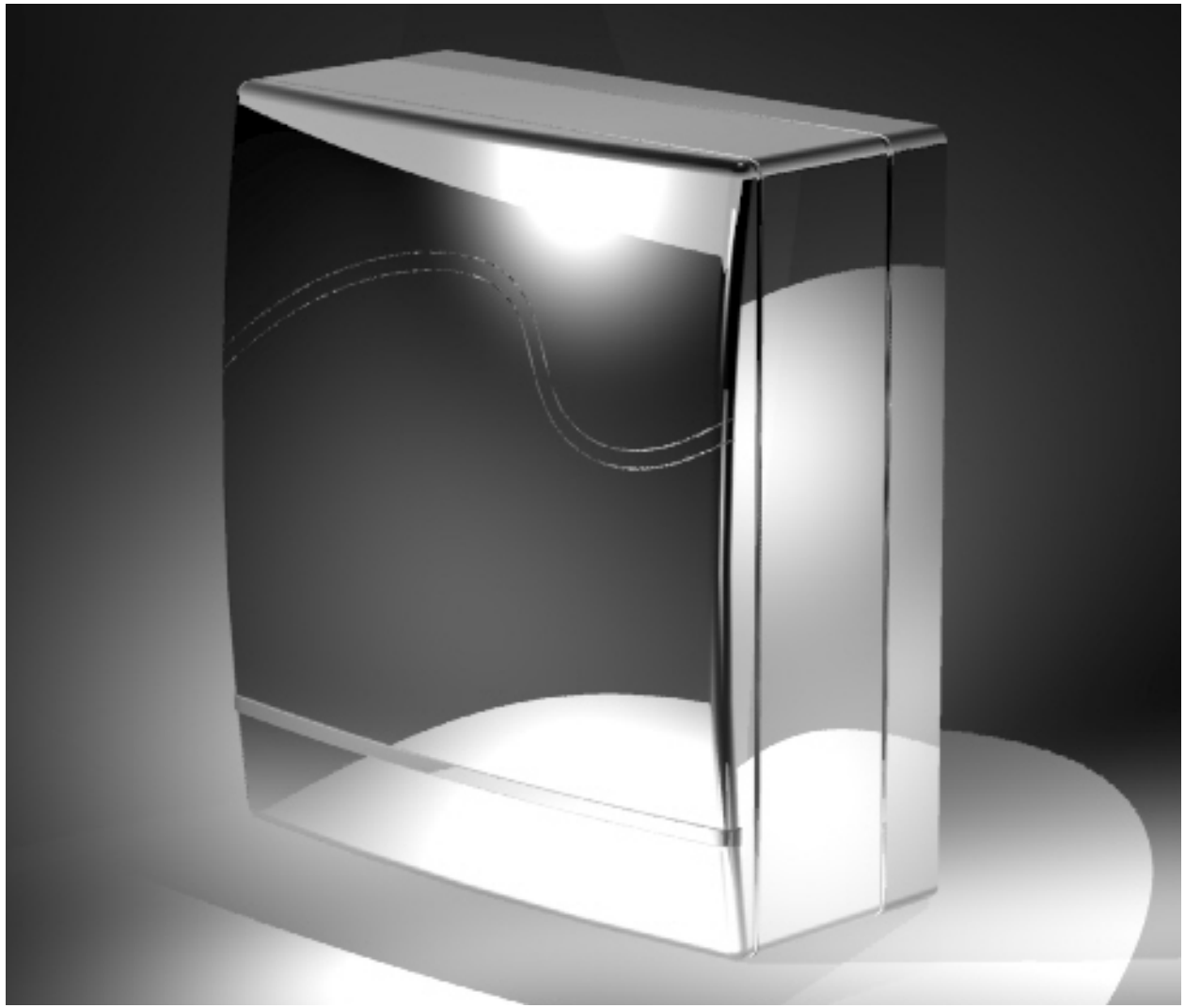
In the second exploration, the curvature of the front door was reduced and the sharp edge on the door was given a slight radius. The grooves on the front door were also stretched further on the side panels. And by one more change, that is by making the op groove straight instead of a curved one the expression change from elegant to static, rather still was brought.

The rest of the lines remained the same, i.e. the door shut line, the spray arm division line and the lower pump area demarcation line on the front door.
On one of the renderings a brushed steel finish was tried out to see how it looked.

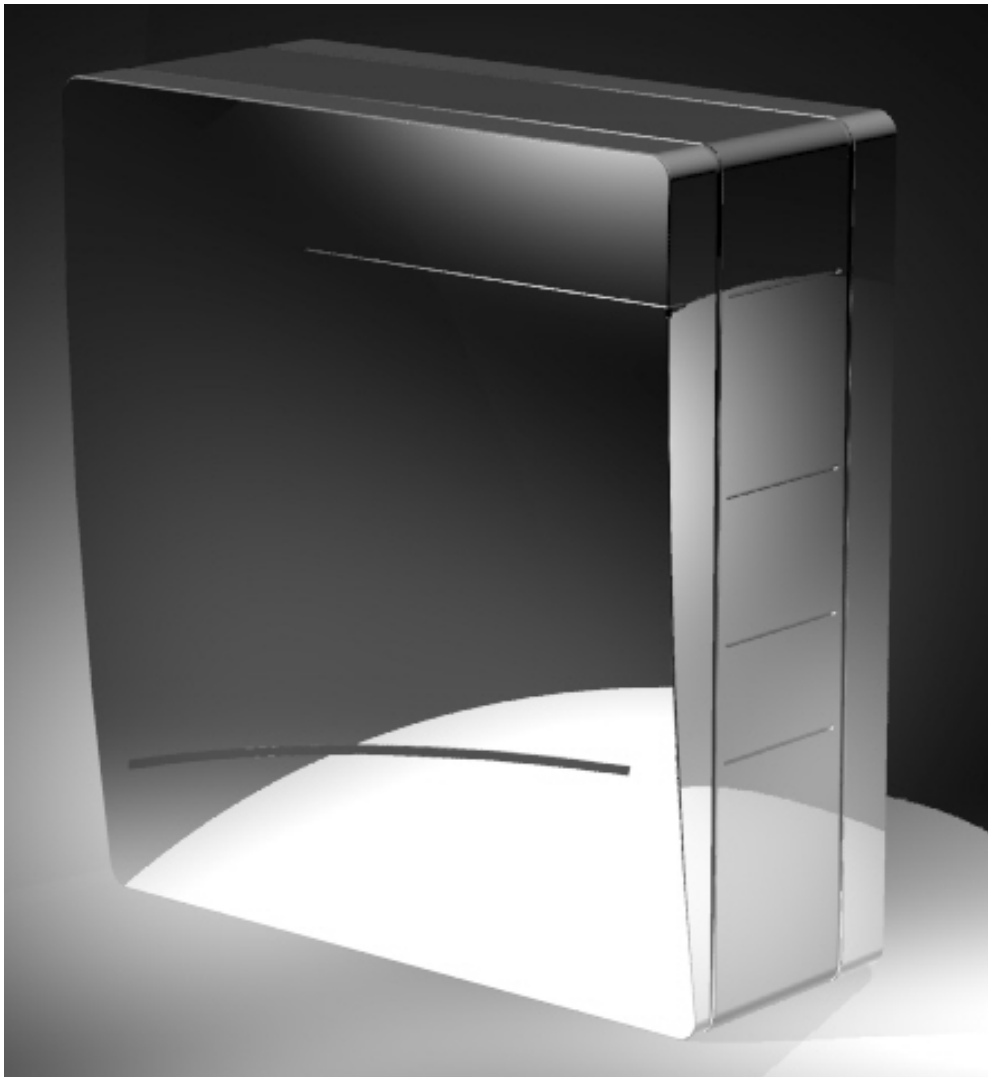


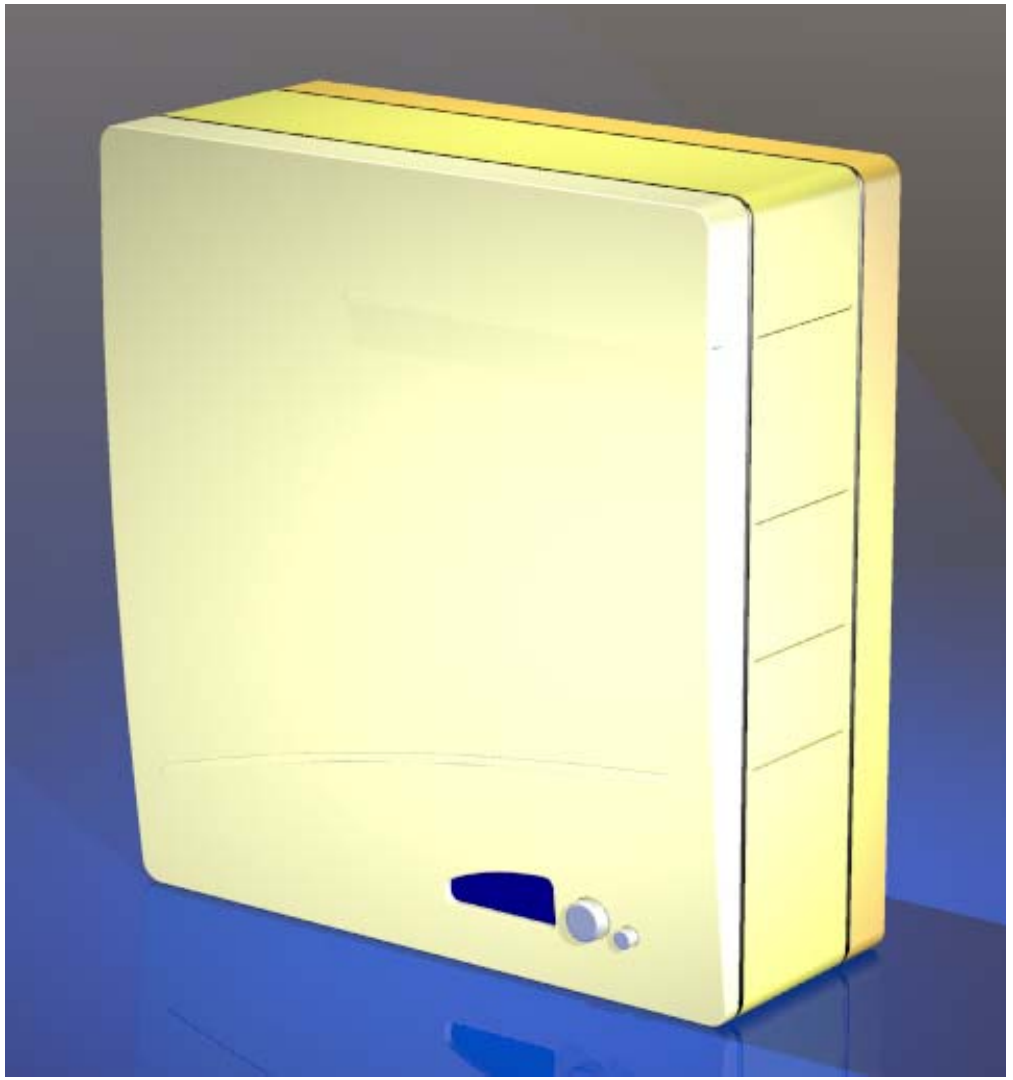
In this attempt, I thought of applying the extension of the radii manipulation exercise taught in the first semester and see how it affects the look of the dishwasher.

Hence keeping the grooves more or less the same the edge radii were drastically increased, primarily on the front door.
The result was that the entire form became a bit bulky and in some sense lost the sharpness and elegance.



The functional considerations demanded the dishwasher to be as less in depth as possible at the lower end, as hindrance with the sink area had to me minimum. It could have been wider at the top. Hence I experimented with a different curve for the door. Also the horizontal groove that was dividing the pump area was changed. The rest of the grooves like the door shut lines, the side panel lines and the back groove were all kept the same.





While it was at one end fruitful to have the steel look, I thought plastic material like that on a fridge would also give interesting results. At first I applied the plastic material on the same previous steel form just to find out how it looks.

With this I had the opportunity to have colour combinations to demarcate the form thus giving me more prospects to visually bring about different expressions.

At first the back area was coloured darker to reduce its bulk. Overall I was attempting to make the form look more flat.

Concept 1

After the explorations, and accessing the merits and demerits of each form, this concept was selected for its clean clear surfaces, and sharp classy yet sophisticated look.

The changes that were made to the exploration were that a rather sharp control panel was added and the top groove was toned down a bit.

Features of concept 1

•Single door that provides more effective sealing

•Clean front that adds minimalist uncluttered look

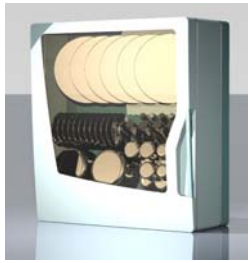
•Stainless steel panels, more durable and lifelong

•More appliance look. Semantically fits well as a dishwasher

•Dishwasher dispenser can be easily located on the inside of the door at a suitable height making loading of the detergent easier

•There is no window though, so cant see what is happening inside.

•The side on which the door opens will determine the corner in which it can be fitted, thereby losing out on flexibility of placing it.

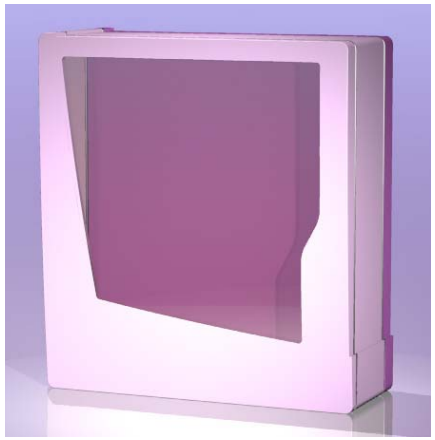


Form generation
Category 2 : Single door opening on one side with window.

This was a shift from what I was doing till now. I thought that giving a window in the front will help me reduce the bulk dishwasher. Again, something dynamic was happening inside, and so why to hide it. The third reason was that, since this is a new concept to the Indian homes, it would be a selling feature if one is able to give the **visual assurance of cleaning.**

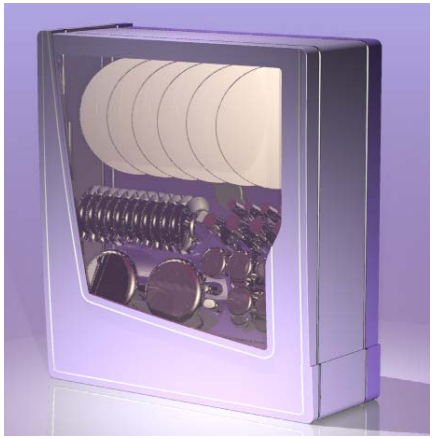
Explorations

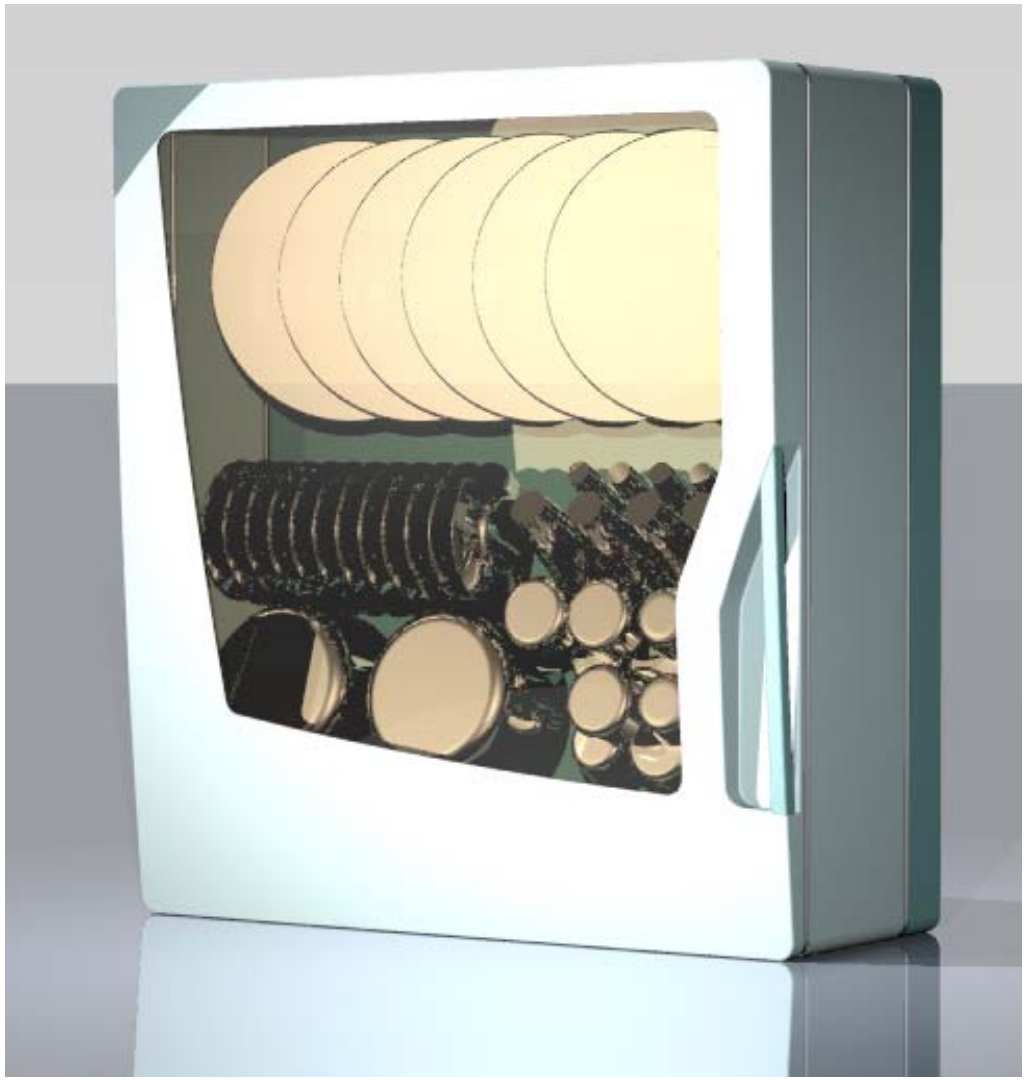
The moment the inside dishes were seen, the entire look of the form changed. It sort of became more alive, more dynamic, though everything inside was static. What would have been the effect when the water would have been sprayed could only be imagined. But I am sure it would have been very interesting
The only possible fallout to this option was that it was a bit less expensive looking. The class was I think a bit compromised.



This is a variation of the same idea but again the effect of grooves to add character in the form was studied. Two grooves on the front door were put, one tracing the door edge and the other the window edge, which was abruptly terminated for that element of uncertainty.

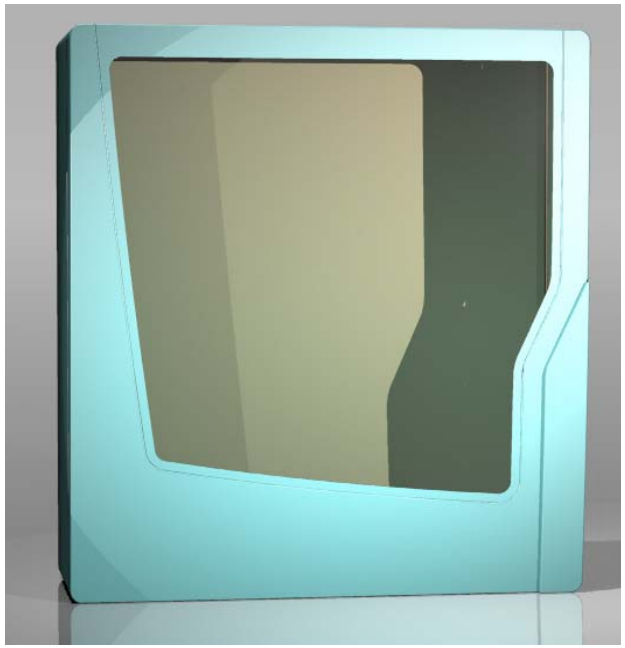
The addition of grooves did indeed make the form more interactive. More inviting and the nature of the grooves helped remove some amount of set staleness.





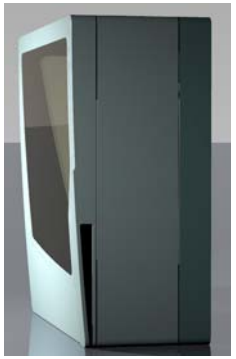
While I wanted the door opening to be inconspicuous, i.e. with out any visible handle, the idea of having one was thought necessary. The next again is a variation with a bold handle given to the front door, suggesting the direction of the opening of the door.

This time the handle was a bit toned down to its usable size because it was interfering with the form a bit too much I thought. Grooves were added to complete the look, and the thickness of the handle was determined by the width of the edge groove. This was done to put in a sense of order, a sense of proportion to the form.



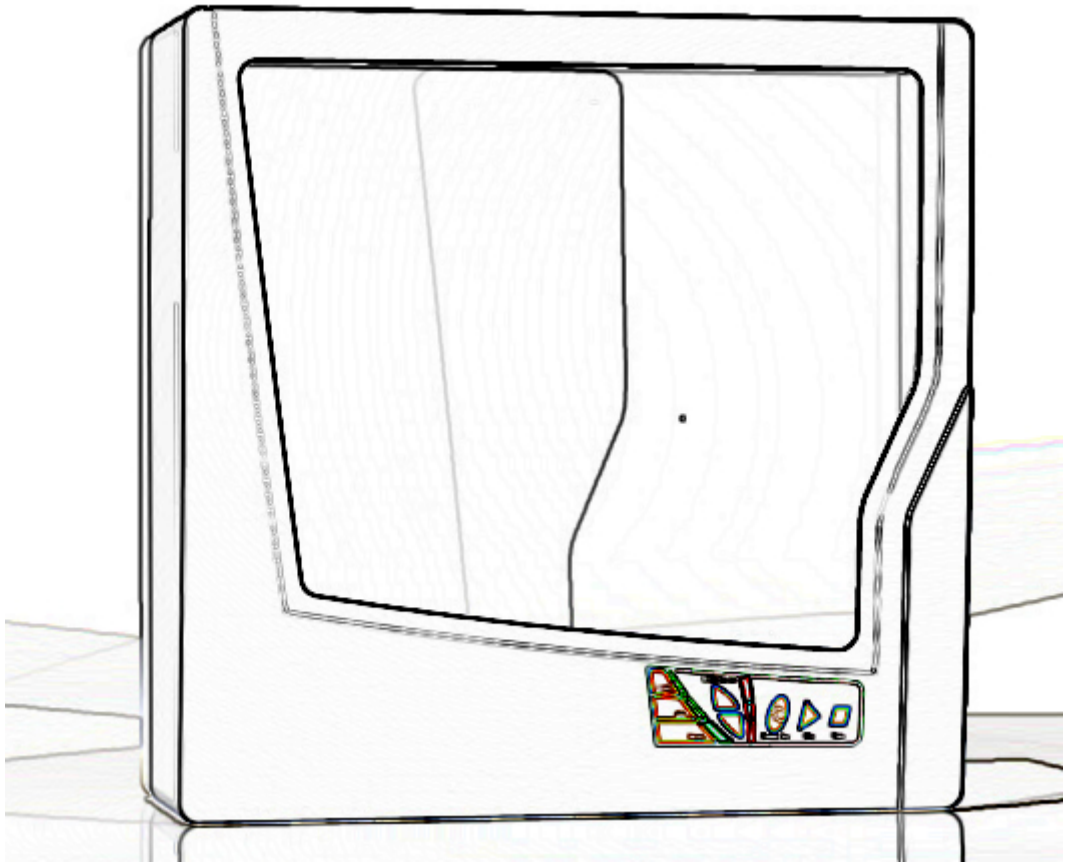
While the kitchen appliance look was intact, the handle was reminiscent of a refrigerator handle. Can there be a handle that is unique to this appliance, sort of something that can form an identity?
The attempt made, made good use of the step in the window on the right edge. a surface tracing the contour of the window was raised by 10mm and a handle slot was given behind it. This step added a elegant variation to the forms front face without disturbing the edges a lot.

The slot given for the handle was increased to full length, so that the user does not have to fiddle to find it. Also it made the door panel more production friendly.



One edge of the window was made straight to see its effect.

Concept 2



The concept of the slightly inconspicuous handle was chosen as the selected concept for this category. A control panel matching with the lines of the window was added to complete the look.

Features of concept 2

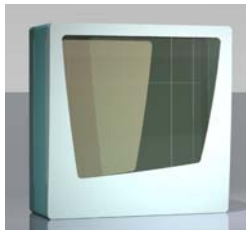
•Single door that provides more effective sealing

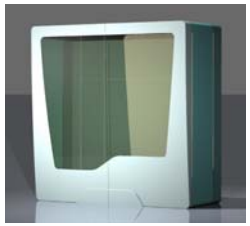
•Transparent window that shows the inside and gives visual feedback.

•Appliance look is a bit sacrificed. So is the dishwasher look of an expensive gadget.

•Dishwasher dispenser cant be located on the door and has to be moved to the interior side wall. Not very difficult to access though.

•The side on which the door opens will determine the corner in which it can be fitted, thereby losing out on flexibility of placing it.



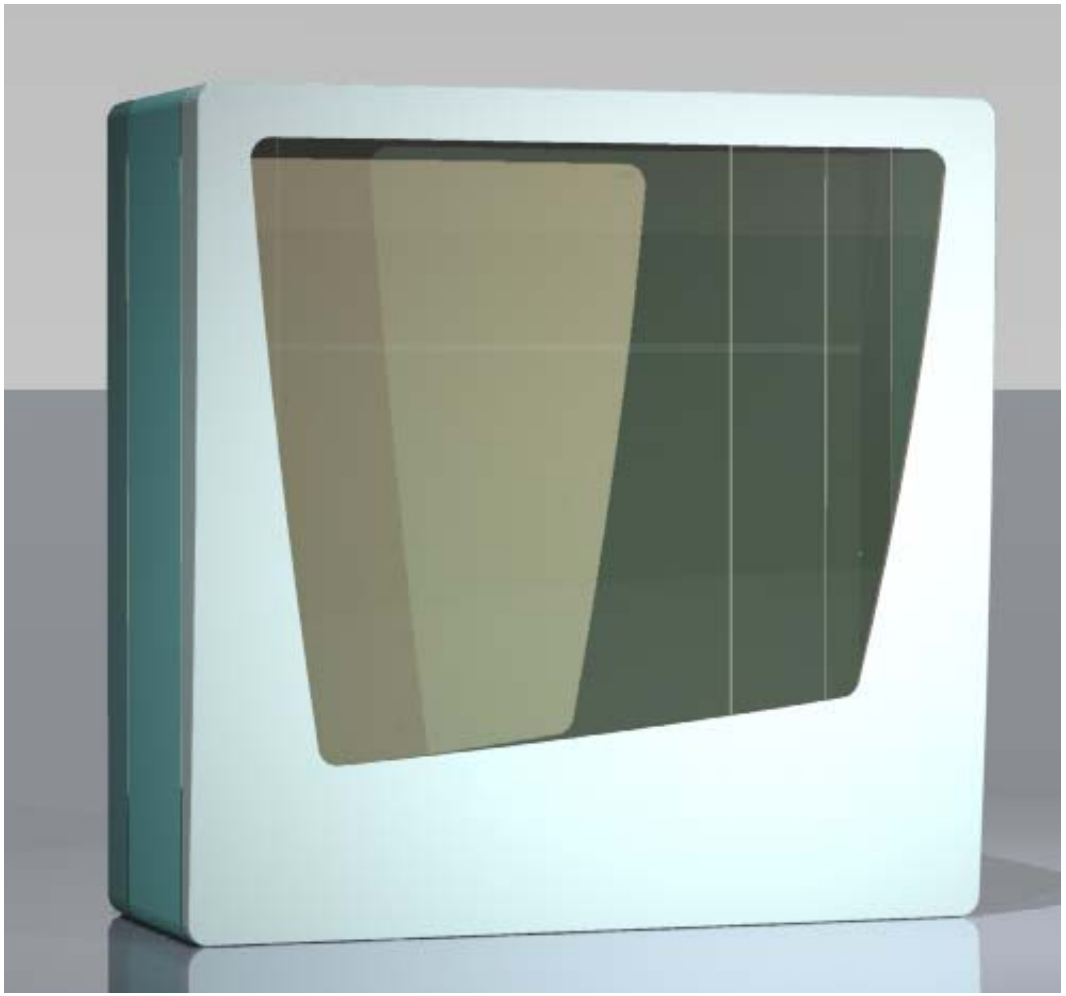


Form generation
Category 3: Single door with window to open from both sides

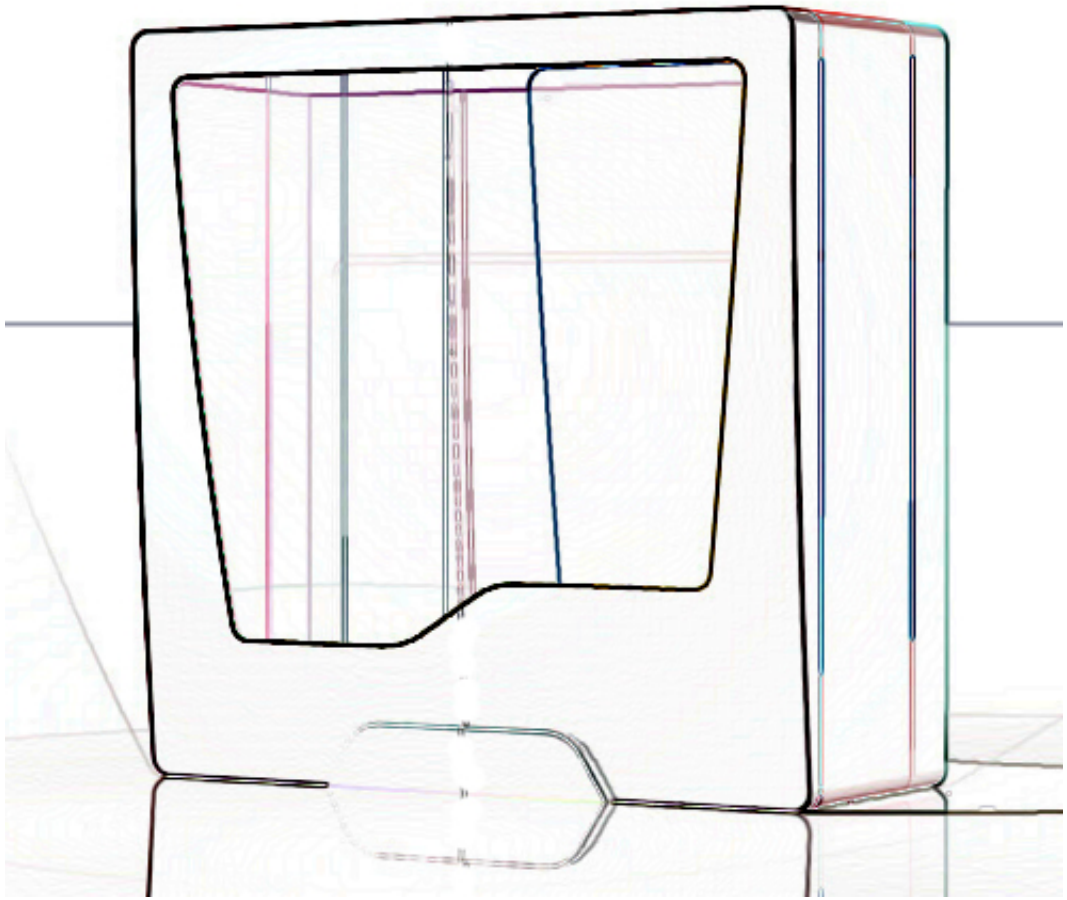
In this layout t thought of providing hinges on the outside on both sides by which after changing a couple of screws the door can be hinged on either side. The handle was brought in the centre, and the window was made symmetric.

Explorations

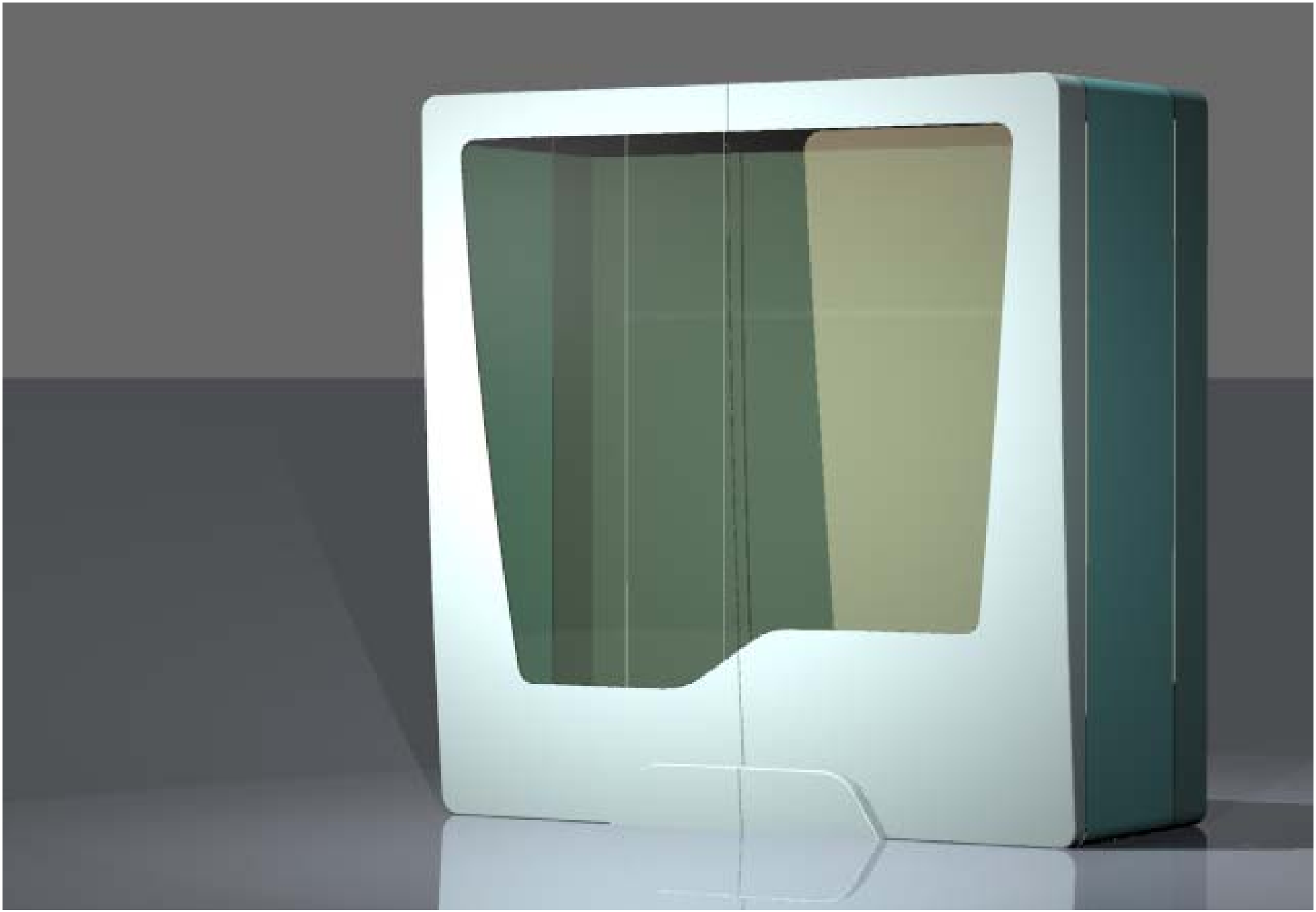
The door of the dishwasher was single door, for reasons of proper sealing. But then if the door opens from the right hand side, then there was no problem if it was kept in the left corner of a kitchen, for then the door would open on the side wall. But instead if the sink was on the right hand side corner, then the door when opened would have come in the way of reaching the dishes in the dishwasher. One solution was a flexible detailing by which after changing a couple of screws the door depending upon the corner in which it was fitted could be opened either from the right or the left. The handle would then have had to be symmetric in the centre, and the window layout would have had to be changed too.
The next concept explores this feasibility



Concept 3



The concept of a door handle much like that of the concept 2, but on the lower edge and symmetrical in the centre to adapt to the situation of the door opening on the either side was selected



Features of concept 3

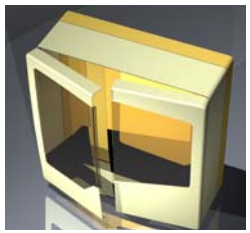
•Single door that provides more effective sealing

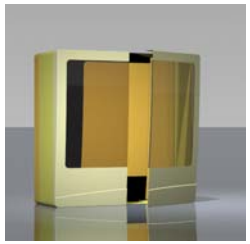
•Ability to make the door open from both sides increases its flexibility to install it in any corner.

•Transparent window that shows the inside and gives visual feedback.

•The symmetry in the window brings the appliance look, a sense of predictability back.

•Dishwasher powder dispenser cant be located on the door and has to be moved to the interior side wall.

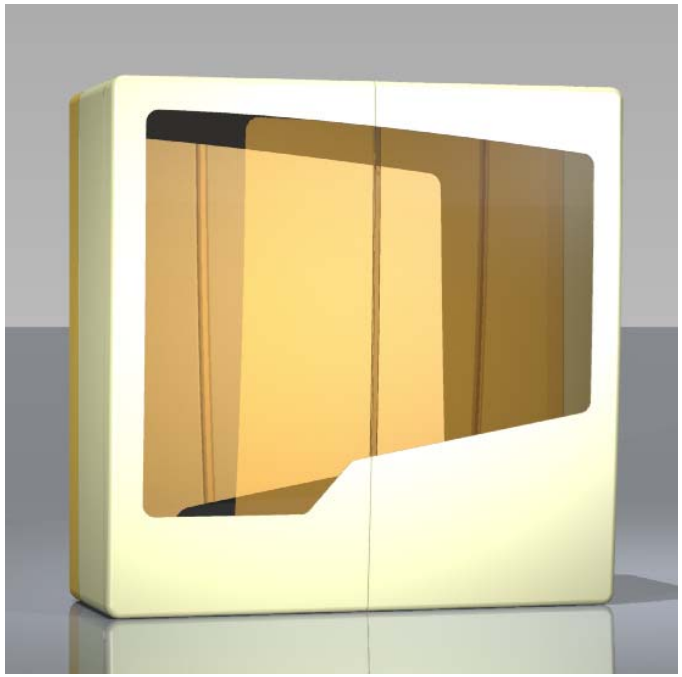


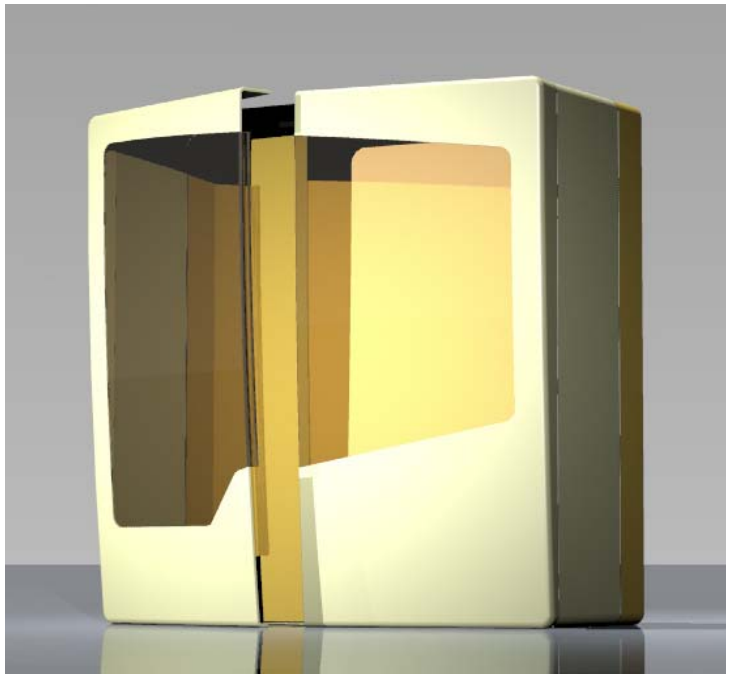


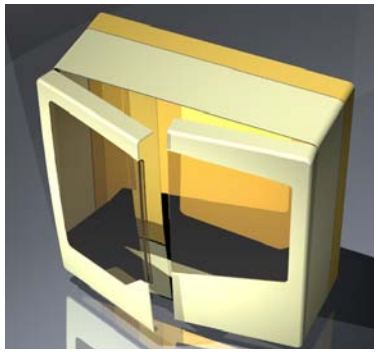
Form generation
Category 4: Split door, Vertical

As the interior layout was getting modified simultaneously, the width of the dishwasher was slightly increasing and hence the door was becoming too wide to be opened as a single door. The user would have had to take a couple of steps behind every time. I thought of splitting the door vertically in the centre, such that it opens in two halves. This immediately takes care of the previous problem of changing the opening side of the door as it could be now put in any corner, and plus wont open too much in the users area of standing.

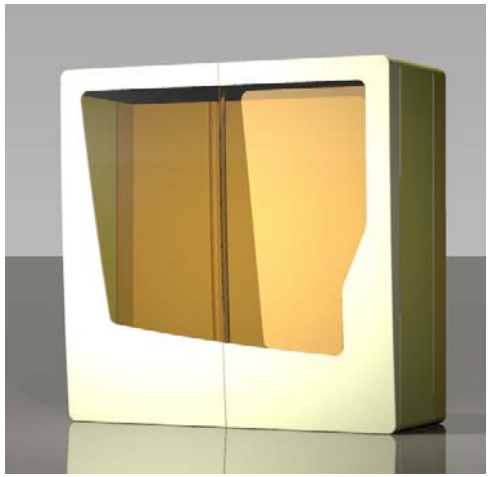
Explorations



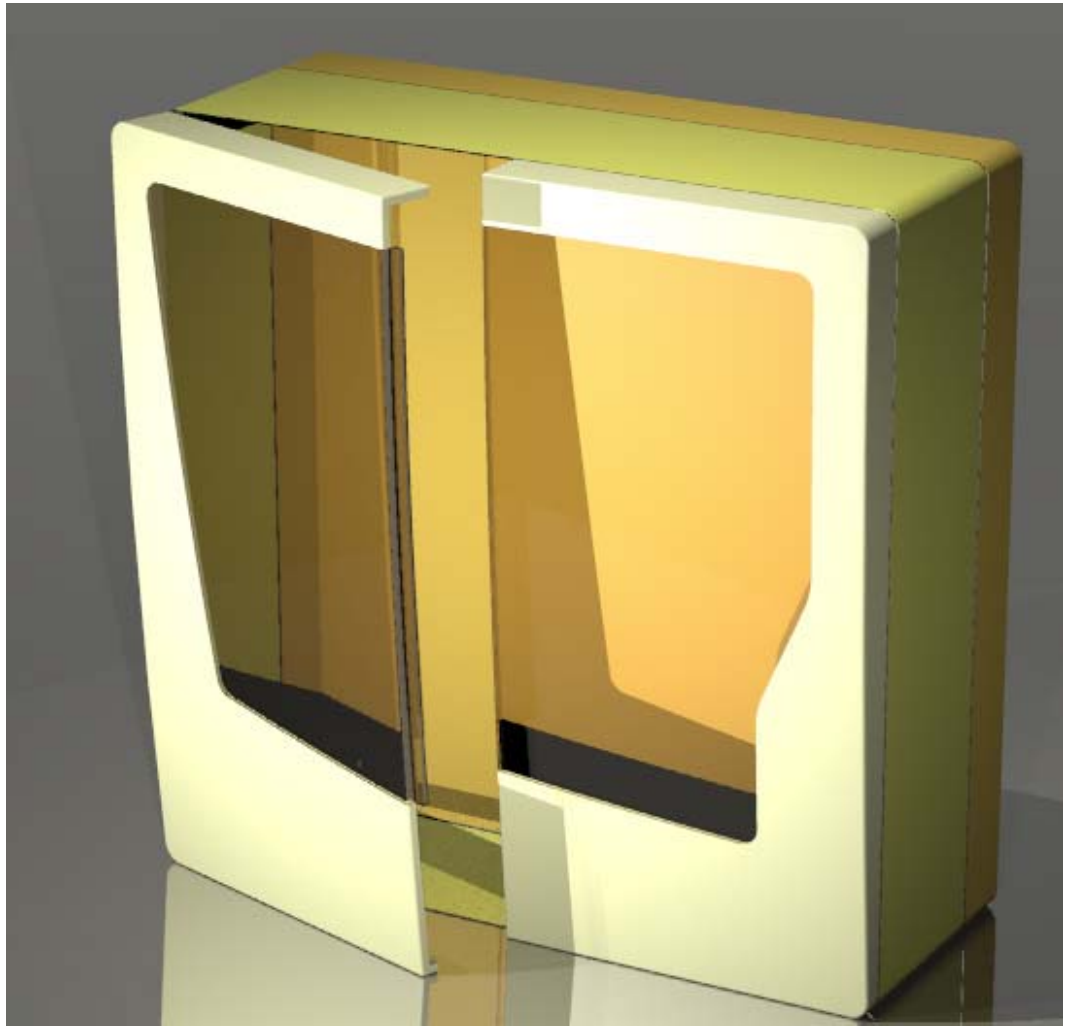


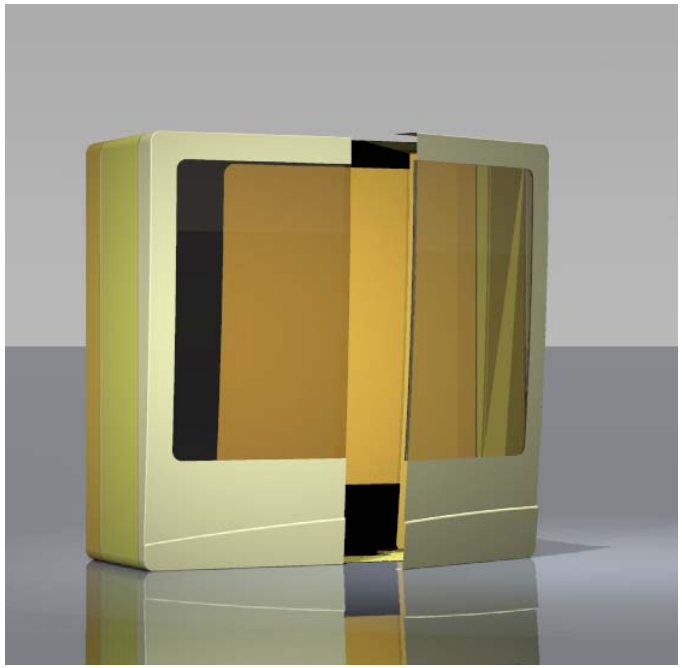


The door was split in the centre, but the idea was to have a single door look when it was closed as I did not want the dishwasher to look like a cabinet. Hence the window was kept such that it was asymmetrical making the split line inconspicuous.



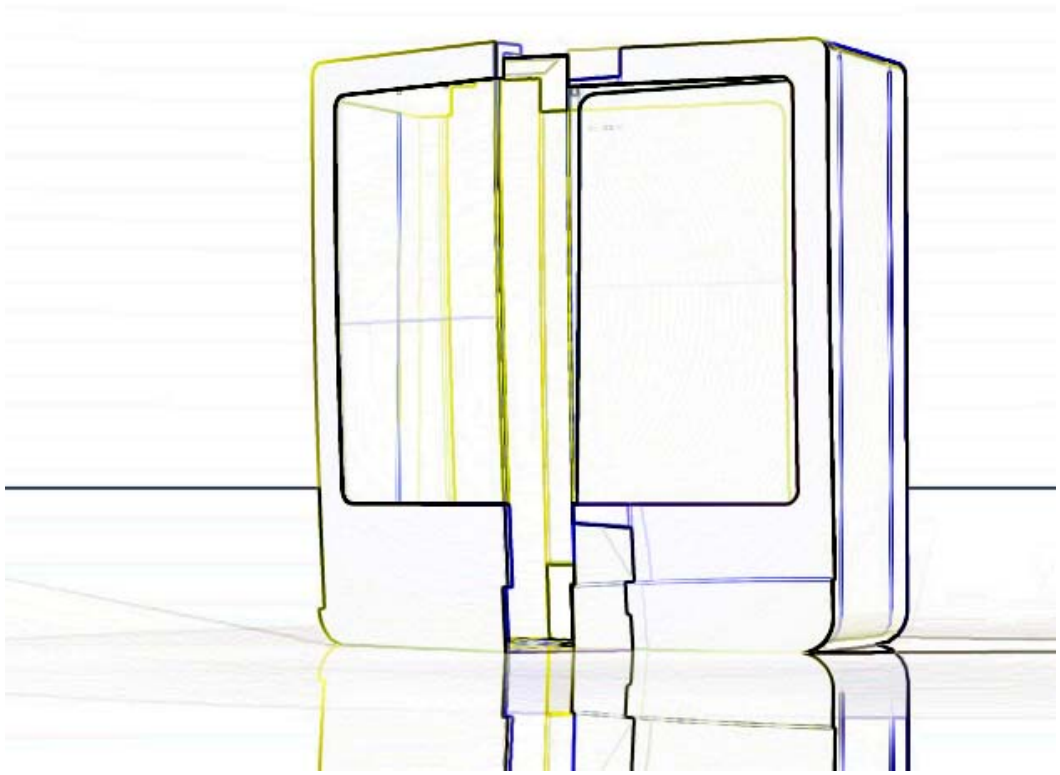
The window shape of the single door concept was tried to see if it holds good. The handle though was shifted from the right side to the bottom centre and was hidden.





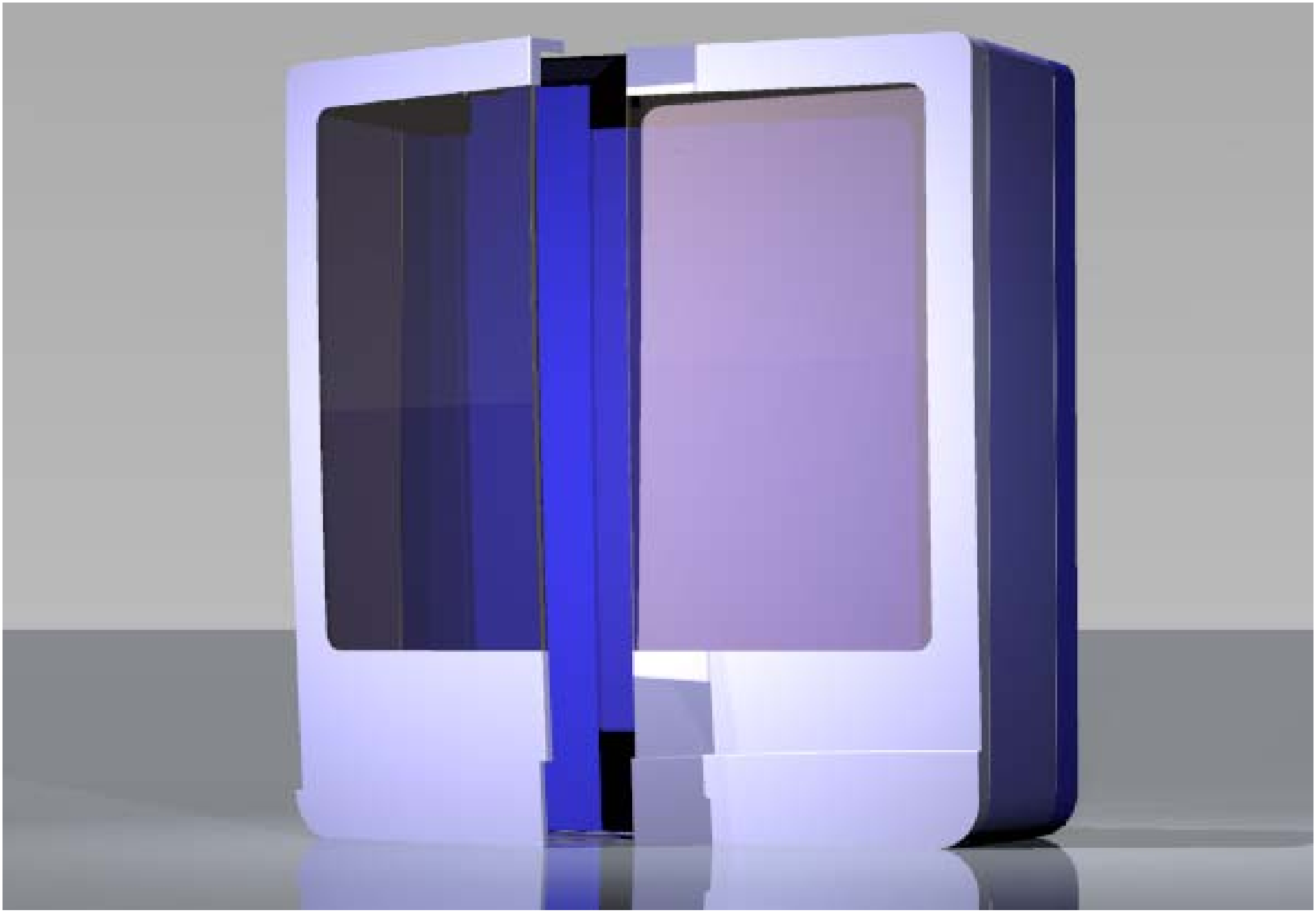
In order to bring symmetry in the split door, and to resolve the sealing detailing, the window shape was simplified. Also the intention was to make it look slightly sober, a bit more moderate, and see how it looks.

Concept 4



The chosen concept is the last exploration in which the radii of the lower edges were made twice the radii at the top. The inspiration was taken from the radii manipulation exercises as I wanted to make the form look lighter at the bottom so that when it is put up on the wall, it does not look bulky.

The simplicity of the window was maintained to have that moderate look



Features of concept 4

•Split door that provides ease in opening and accessing the interiors

•Can be placed in any corner

•Transparent window that shows the inside and gives visual feedback.

•Appliance look is a lot sacrificed. So is the dishwasher look of an expensive gadget. Has started looking like a cabinet or a furniture piece.

•Sealing the door and still have the window transparent is a bit of a challenge.

•Dishwasher dispenser cant be located on the door and has to be moved to the interior side wall.

Form generation
Category 5: Split door, horizontal

All said and done.....the vertically split door was scoring too less on dishwashernees and applianceness. The reason was that it had started looking more like cabinets that are found in the kitchens. Furniture like feel was seeping in to it making it look too elementary. The drawback was too intense I thought. Also the sealing was an issue especially with the transparent window in the front. It was not impossible as with the help of transparent PVC gaskets the transparency of the window would have been maintained. But a different approach was needed.

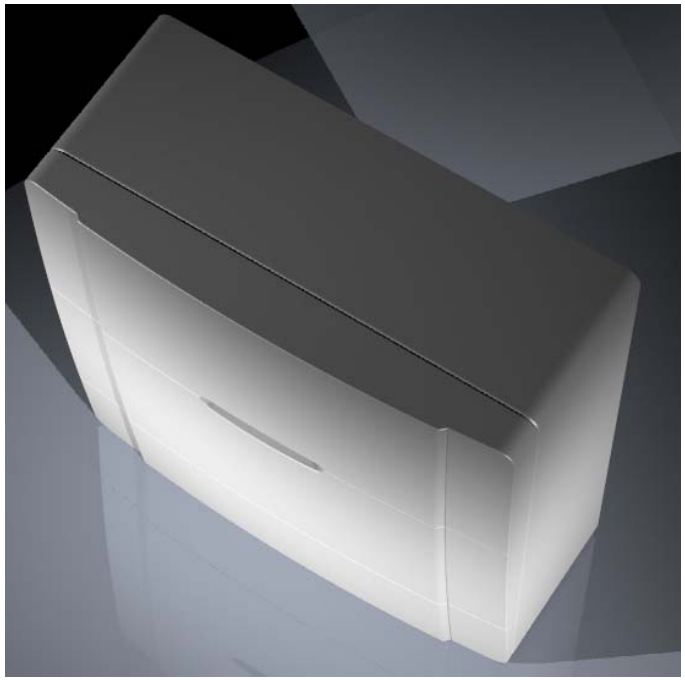
At this point I thought hard on how to bring the dishwasherness, and applianceness back in the form. What was missing was a bit of that expensive look in the forms with windows.
At the same time the door needed to be split. The size demanded that.
First I thought of doing away with the window and having a clean surface in the front. This helped bring back that appliance look.

Then I thought of splitting the door horizontally. The lower half opens down and the handle is on this part. As it opens down, the upper half of the door goes up. Even while closing only the lower door needs to be pushed up in place and the upper part would come down on its own with the help of mechanical linkages and pneumatics.

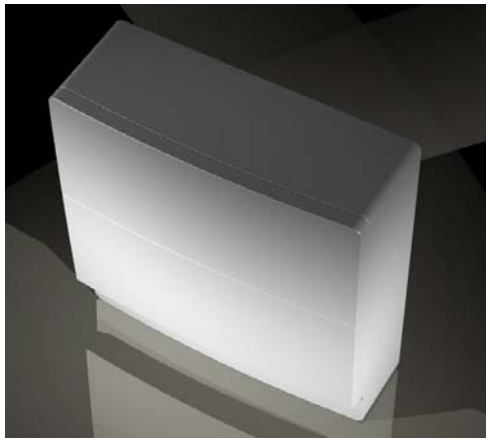
Explorations

The appliance look was brought by treating the form in a subtle way. Soft curves to the door panels were added to remove the boxiness. The vertical step was put to break the visual grammar and make it look slim.

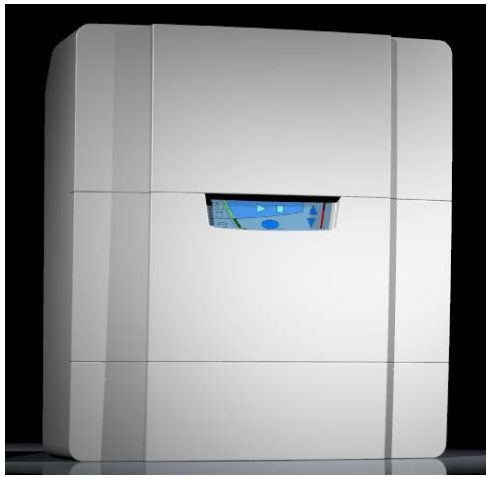
Control panel was a black LCD display which lighted when the dishwasher was turned on.



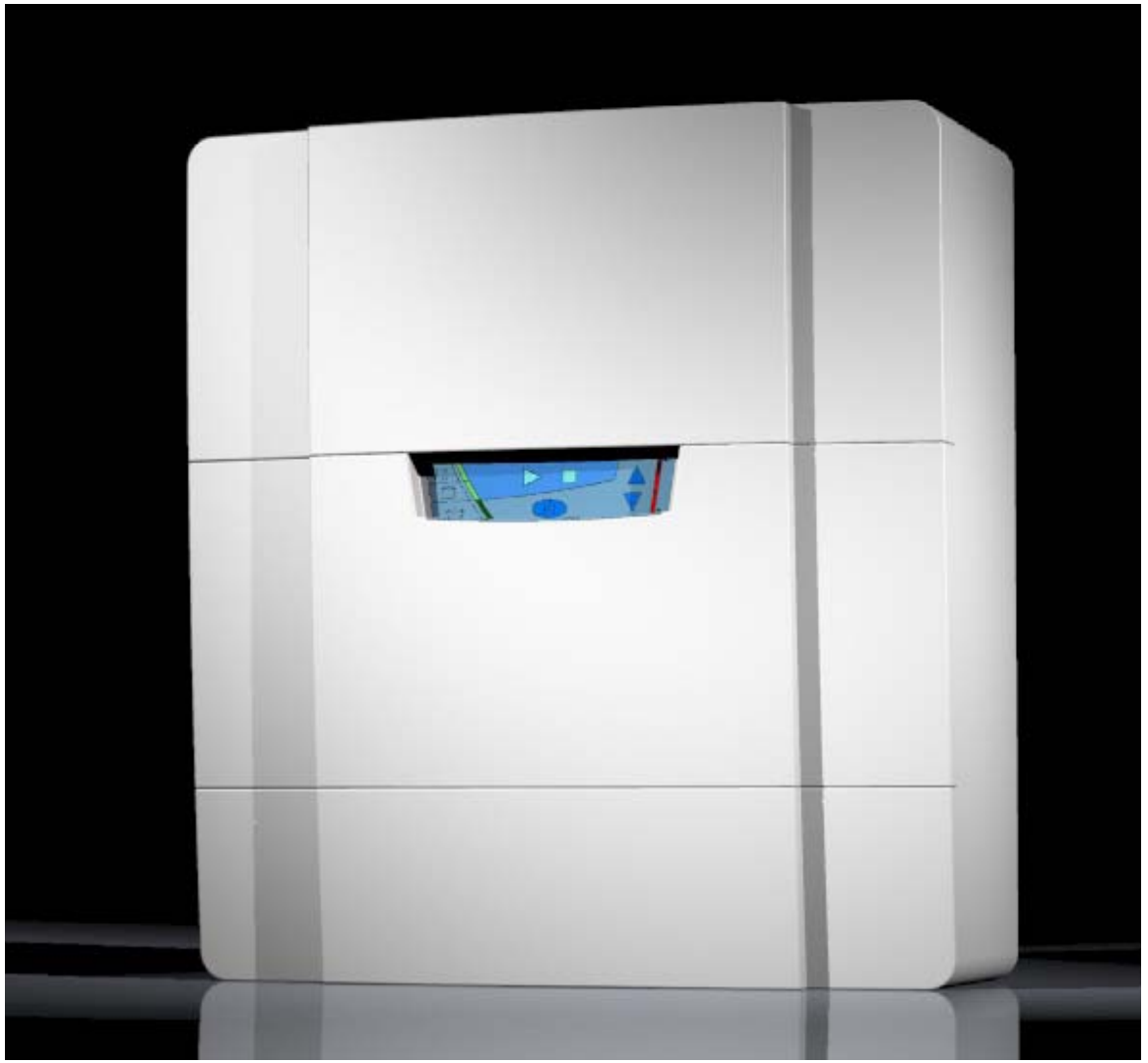
A handle was added such that it disguised the split line of the door. The bold control panel removed was removed.



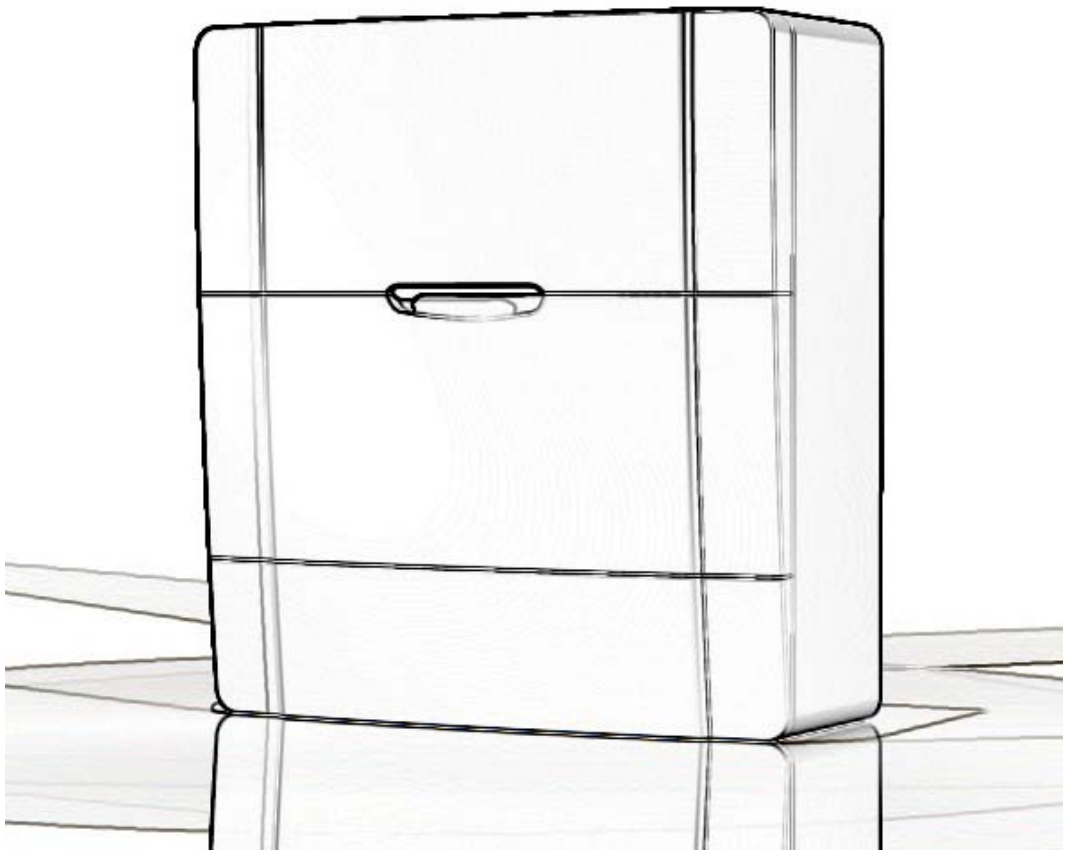
In this variation the lower portion where the pump and motor are was given a recess such that when fitted above the sink it should not hinder with the sink area. But the gentleness of the form was lost in that bargain.



The control panel was put in a recess which is a handle in disguise. Also the recess was a part of the lower door only and the split line was made obvious



Concept 5



Taking clues from the explorations the vertical step was reduced to make it subtle and the split lines were made continuous. The idea of door handle was dropped. The control panel will merge with the surface instead of being in a recess

.

Features of concept 5

•Horizontally split door that provides ease in opening and accessing the interiors

•Can be placed in any corner

•Appliance look is very prominent. So is the dishwasher look of an expensive gadget. Has started looking like a proper kitchen aid.

•As there is no transparent window, sealing the door is easy.

•Dishwasher dispenser can be located on the lower door and hence is easily accessible.

•The lower door can act as a temporary shelf while loading the dishes. If the dishwasher is not placed over the platform, near the sink, then this door will help contain the water that will run down from the dishes while loading them which otherwise would fall on the floor

•There is no window, so there is a lack of visual feedback

9 Final Form Selection

Evaluation was done of the concepts and they were compared on the grounds of ease of loading and unloading, form, location, and location of the internal components.

The method adopted was the same as that of the vessel layout evaluation.

A point that should be noted is that since concept generation was a linear process, much of the good points of the earlier concepts were added to the newer ones and hence the last concept emerged out to be the best.

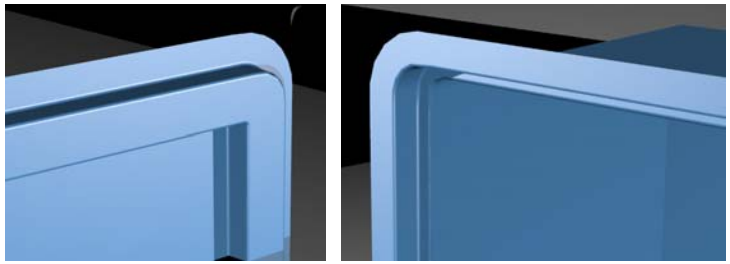
Evaluation chart

	Concept 1 Single door opening on one both side	Concept 2 Single door opening on one side with window	Concept 3 Single door opening on both sides with window	Concept 4 Vertically split door with window	Concept 5 Horizontally split door without window
Ease of opening and accessing the dishwasher (10)	3	3	3	4	4
Looks, in terms of applianceness, dishwasherness and expensiveness (8)	4	3	2.5	2	4.5
Flexibility in locating (8)	4	2	4	4	5
Location of components (6)	4	2	2	2	5
Visual feedback (4)	-	5	5	4	-
Total	118	102	114	116	146
Rating	3.27	2.83	3..16	3.22	4.05

Concept 5 scored the most and was selected for further refinement

This is the exploded view of the two steel door panels and the steel tub in which the rack is fixed. The steel tub had a step at the edge and the door panels fit into that step sealing it with a gasket in between.

View of the steel door panel and the door plastic panel assembled together.

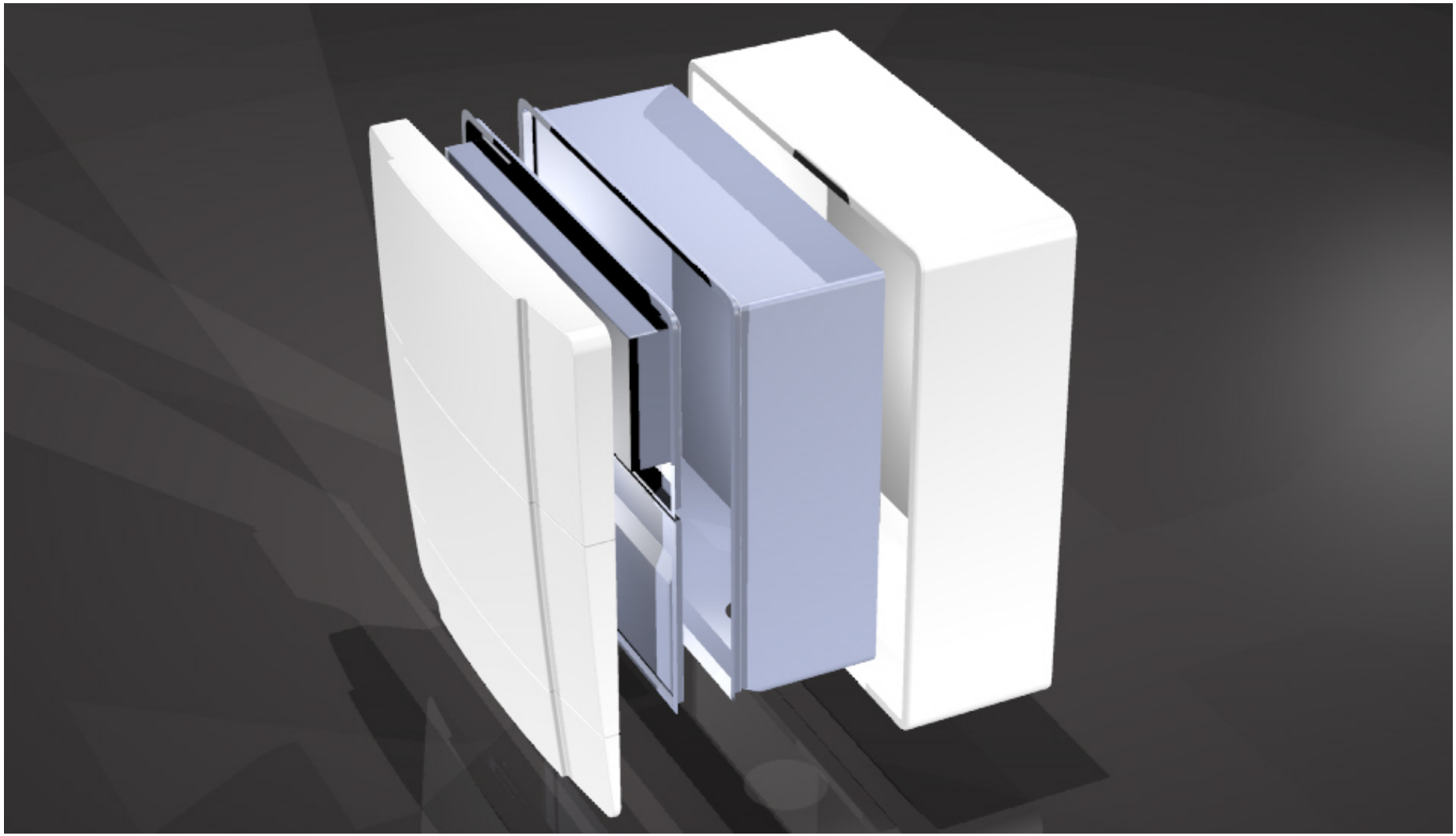


Close up of the door and the tub edge

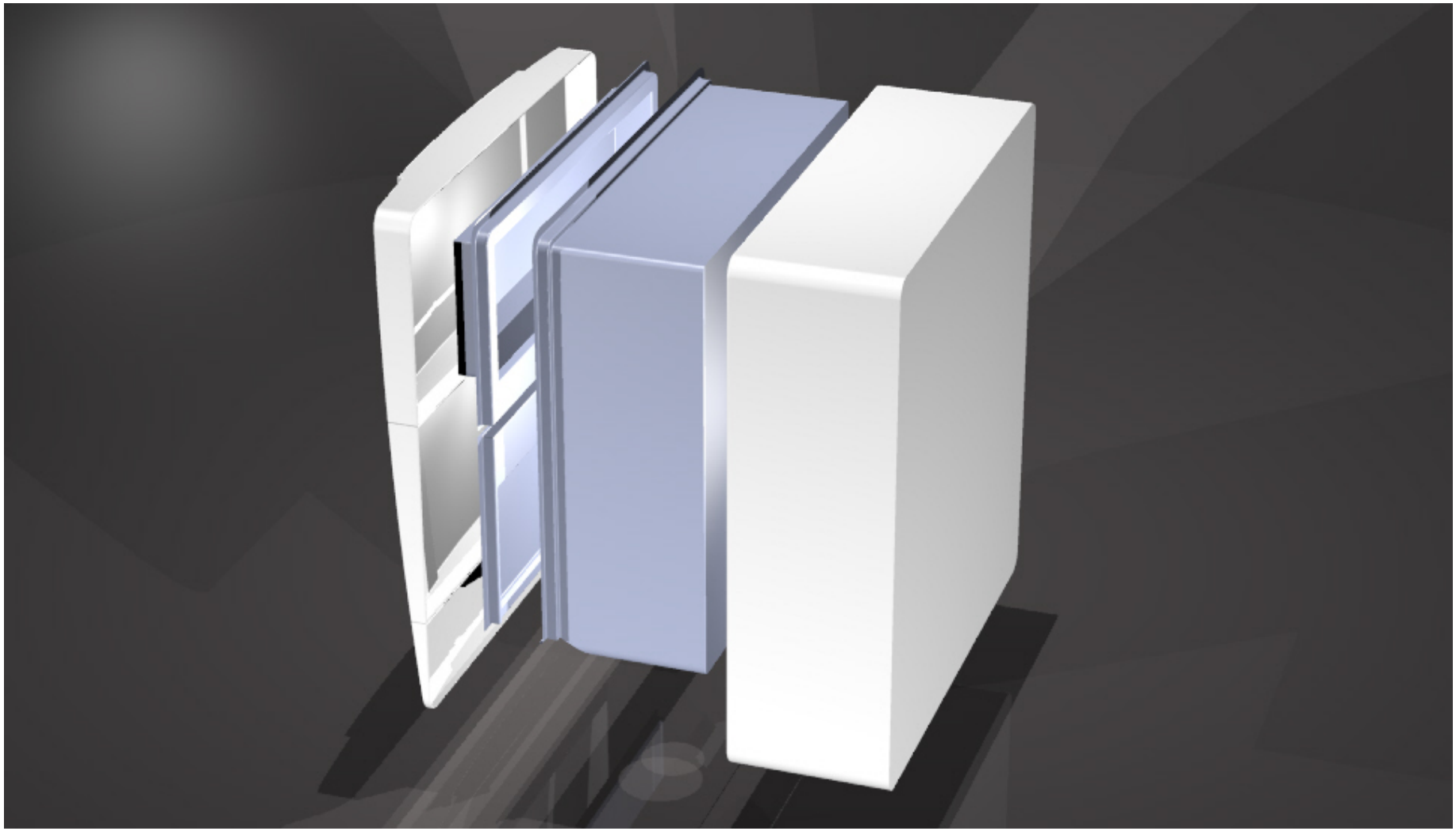
Steel tub fixed to the main plastic body

All the steel and plastic body parts

The assembly

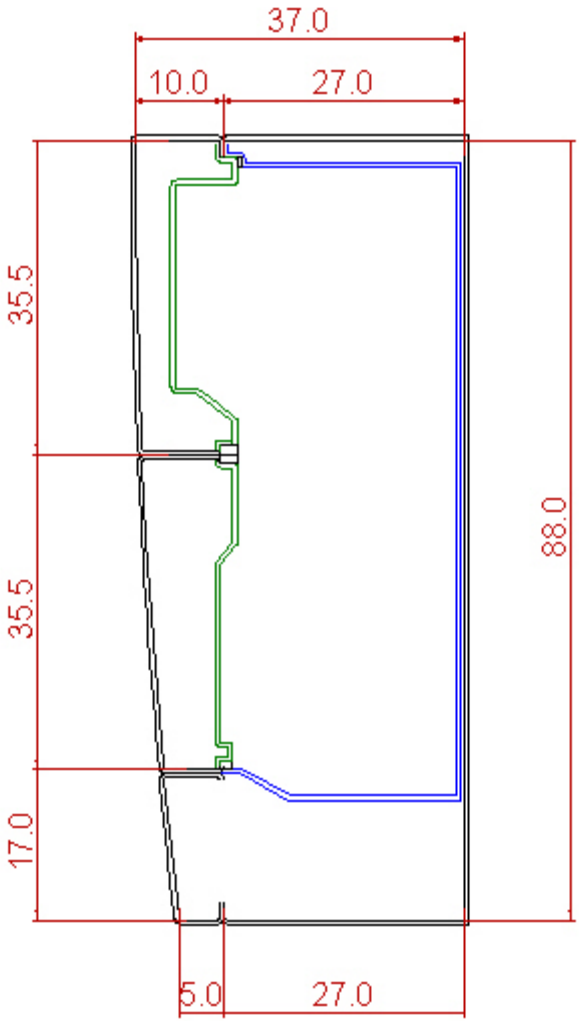


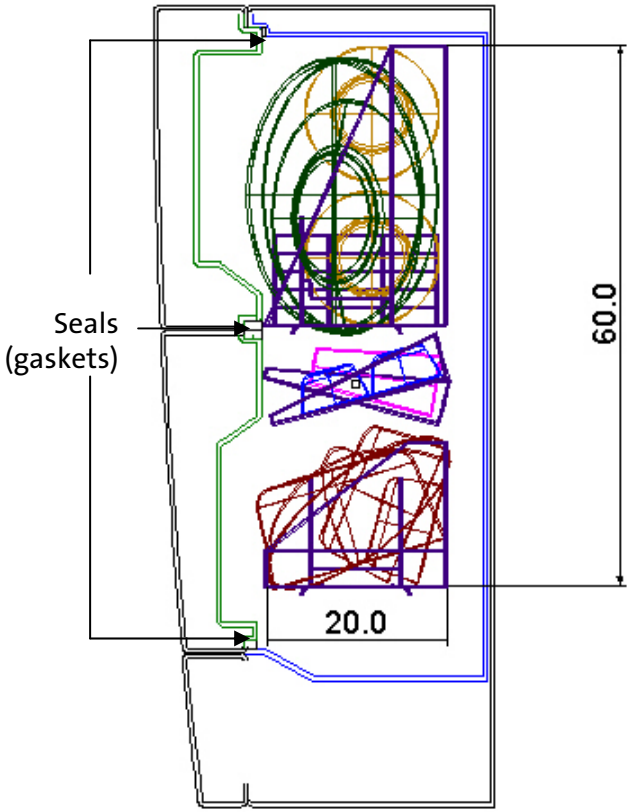
The assembly



Sectional Views

(section line passing through the centre)

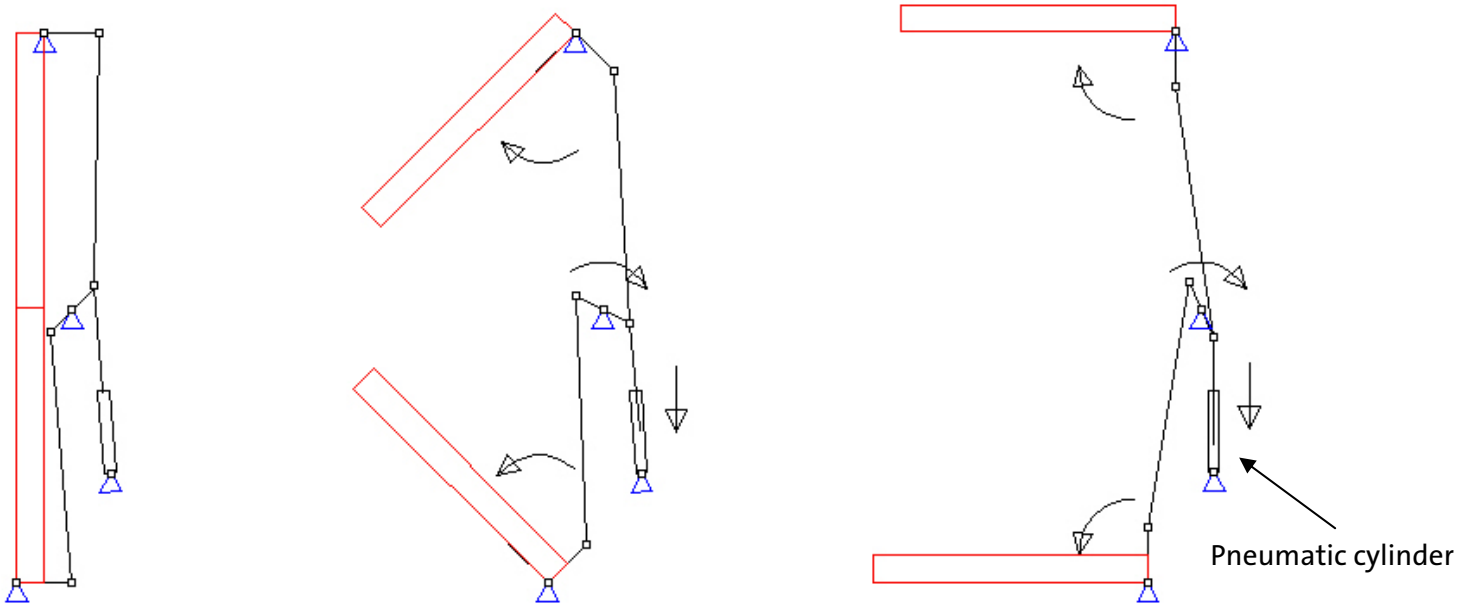




Door opening mechanism

For the upper door to open up on its own when the lower door is pulled down the following linkage was designed. The arrows indicate the direction of travel of the door and the linkages.

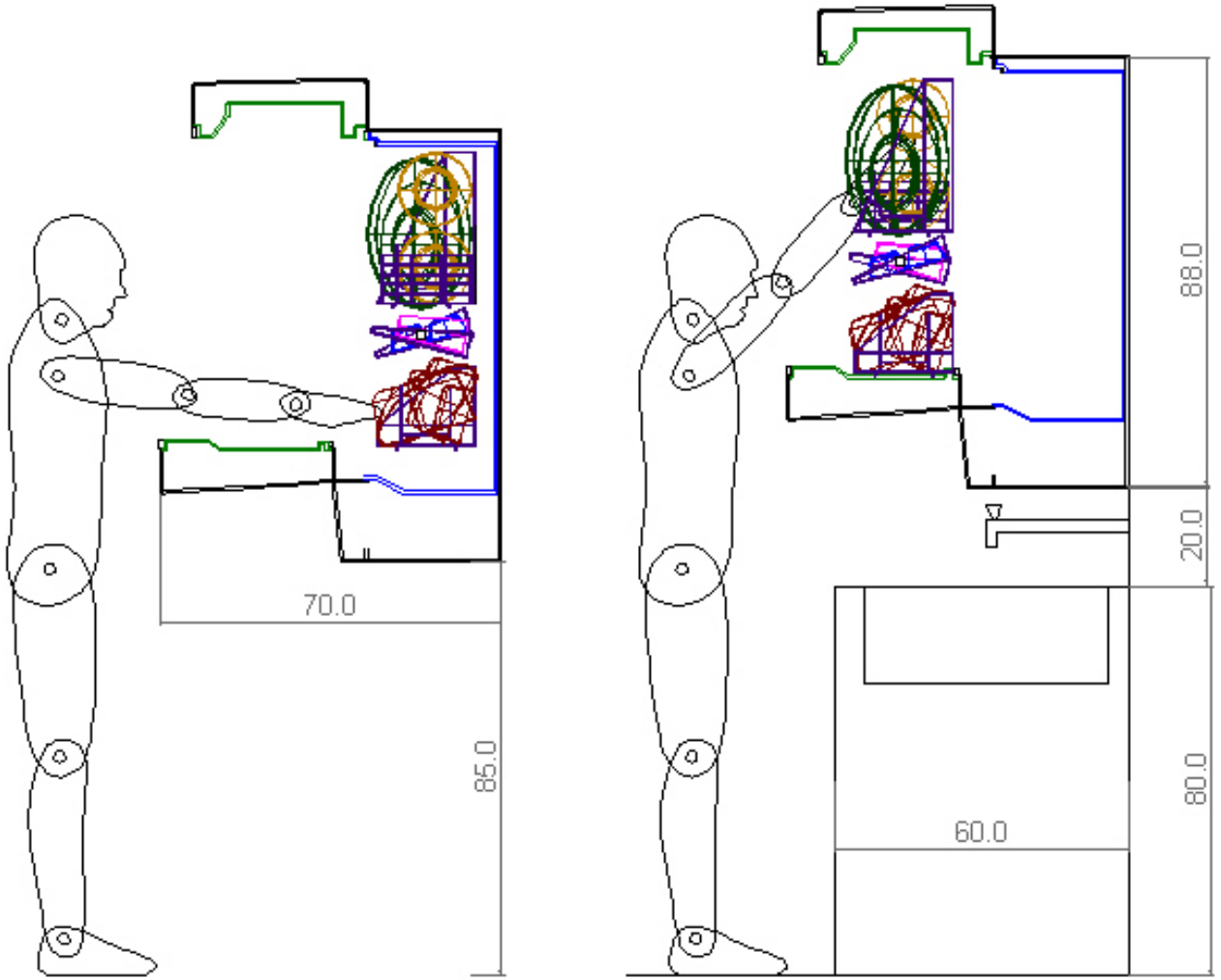
As the lower door is opened in the direction of gravity, the linkage charges a pneumatic cylinder that later expands and assists in closing the door.



Ergonomic analysis

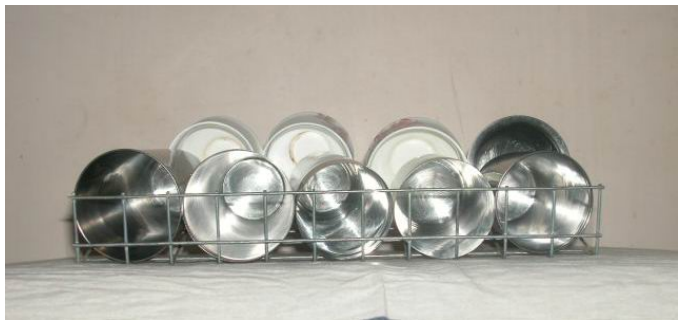
The figure shows the analysis of two positions of attaching the dishwasher for a 50%tile indian woman.

Even in the extreme case where the dishwasher is put exactly above the sink all racks are reachable. The sink area will be a bit compromised bit is very much accessible.



Model making

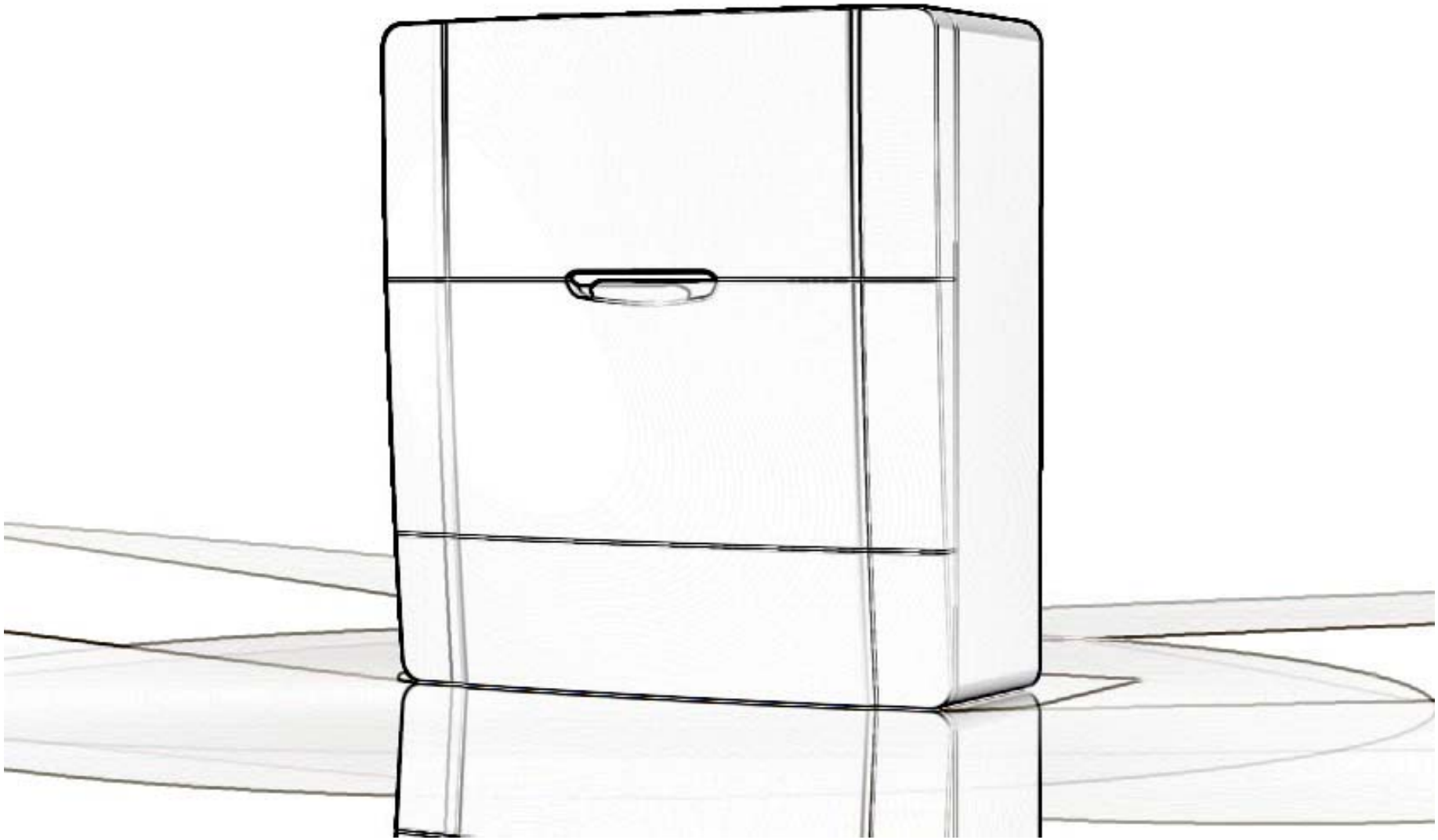
Katori rack



Glasses rack

Vessels rack

Total vessels in the lower racks



Final model

References

Books

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Net search

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Questionnaire for user survey

To the lady of the house

Does she do the dishes or a maid is hired?
Does anyone else help her?
Is there a dishwasher in the house?
Do they aspire to have one?
How many times are the dishes cleaned in a day and when?
All at once or in small batches, like if teacups etc. are washed as soon as tea is had?
Are the dishes done at night or the following morning?
If so, are the dishes rinsed or kept as it is?
Who sorts the waste?
What utensils are used daily? Ratio of steel and glass ware?
Are all utensils used with washing powder or are some just rinsed with water?
What is the average count?
Is there a soaking time?
Is hot water used?
How much time does it take?
Are the dishes wiped dry or kept in the stand to be dried?
How much is the maid paid?
Hoe many times does she come?
Does she ever complain? And abt. what?
Does she wash the dishes differently than u do?
Who is more elaborate?

To the maid

Hoe many houses does she cater to?
How many times?
What is the pay?
What is the average time and count per house?
Does she have a preference to a culture and why?
Does every family sorts the waste or she does it?
Are the dishes rinsed and kept for her?
Does she have to waste an extra time cleaning the dried waste dishes?
What are the most common washing powders used?
Does she recommend any and why?
What kinds of scrubs are used?
Are different scrubs used for different kinds of utensils?
Does she dry the dishes too and how?
Does she know about a dishwasher?
Does she consider it as a threat?

To the dealer

How many brands are available?
What is the price?
What is the capacity?
Do people come to buy it?
How many have brought form their shop so far?
What are the features?
How many cycles are there?
How to load the dishes?
Does it clean efficiently, and what is the guaranty of it?
What are the kinds of detergents?
Why rinsing aid is added?
Why salt dispenser?
What is the cycle time?
What is the power consumption per cycle and how much does it cost to run the dishwasher once?
Do people at least come to enquire about one?