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Ayushi is currently pursuing her Bachelors in Design at Delhi Technological University (Formerly known as Delhi College of Engineering).

She chose the field of industrial design over others because she's passionate about creating beautiful, elegant as well as functional designs out of raw ideas. She's not only a dreamer but also a doer and goes to great lengths to convert those dreams into reality. Other than that she can be seen rocking to the beat.

POPUP-TOASTER

ABSTRACT

The main aim of this project was to redesign the exterior of pop-up toaster keeping in mind the pain points experienced by the target audience while interacting with it. Toasting is a process in which slices of bread, of any kind, superficially, attain a slightly charred and caramelised surface having a brownish hue to it.

The most common household toasters are the pop-up toasters and toaster ovens. Apart from these, convection ovens and toasters are also available for commercial use, in restaurants and big kitchens. The process of toasting bread in toasters has remained nearly unchanged since its conception in the early 1900s, albeit the fast-paced and enormous developments in technology over time. However, there is an enormous scope of innovation with various features by playing with the form, aesthetics, and material.

INTRODUCTION

Toast is one of the reigning components of breakfast foods across the globe. This seemingly bland, crunchy piece of carbohydrate can be paired with almost anything and act as a supplement to it. Since toast is firmer than untoasted bread, it becomes easier to spread toppings on it. It is generally eaten with butter, sweetened toppings such as jam, or savoury toppings such as peanut butter or yeast extracts in some parts of the world.

Toasting refers to, mostly, browning of bread slices due to constant and concentrated exposure to radiant heat generated by a heating element inside the toaster. This radiant heat is essential to initiate a non-enzymatic reaction called the Maillard reaction, responsible for altering the texture, odour, taste, and moisture content/elasticity of the bread.

In toasters, there are slots made of stainless steel for the bread slices to go into and are surrounded by fragile, nichrome wires throughout. These wires are a part of a circuit which gets closed by pushing the lever down after setting the thermostat. This enables current to flow through the circuit. Nichrome wires have very high resistance, and so, glow bright red and radiate extreme heat when current passes through them, effectively toasting the bread slices. More significant the intensity and duration of heat in contact with the bread slices, the browner they become and the more moisture they lose.

A Pop-Up toaster was studied, and the following research was done to go through the redesign process.

- Surveys through questionnaires
- Task analysis & Sketches
- Analysis leading to:
 1. Problems fundamental to almost every demographic & their possible solutions
 2. User persona
 3. Persona directed pain points
 4. Final brief
- Sketches of existing products

In order to find and identify problems present in pop up toasters, a 20-year-old college student was observed while toasting some bread slices in the toaster. The entire task was documented from start to finish through pictures and sketches; the documentation stretched from unboxing the toaster to cleaning it after use.

A survey was done of sample size 50, with different age groups and occupations, through questionnaires. The tasks above were done in order to empathise with the users and better understand their aspirations. This method helped in identifying the frustrations and pain points experienced by the users.

Mind maps were used to figure out possible solutions. The survey and interview data was analysed, and a persona of the target user was generated. This pain point of the persona was fundamental across almost all demographics, and hence these were taken up to while redesigning the toaster.

The next steps included:

- Studying Ergonomics
- Learning about different materials
- Taking inspiration from already existing products and their forms
- Coming up with different concepts, some of which eventually got converged to form the final concept
- Prototyping (Thermocol and 3D CAD model)

This whole redesign process employed the 'Double Diamond Model' as well as the 'EDIPT – Design Thinking Process'.

OBJECTIVE

The main objectives of this project were:

- Researching and analysing the various designs of pop up toasters, study the timeline of toasters, in terms of their form, ergonomics, colour and material.
- To understand the psyche of the target users through User research.
- Redesigning the product that helps address the critical problems faced by the users.

NEED STATEMENT

The need for this project was to redesign the outer casing of pop up toaster in terms of its ergonomics, form, and aesthetics while improving the appliance's usability and intuitiveness.

BACKGROUND STUDY & RESEARCH

ERGONOMICS

Different grips were studied and found that the cylindrical grip and hook grip to best suited for gripping the toaster on both sides in order to invert it and shake it vigorously to get rid of the crumbs.

The bottom part of the toaster was designed in such a way that it followed the contour of the palms of the hands. It was done for the people in the 5th percentile because doing so will make sure that the 95th percentile will be able to grip the appliance as well.

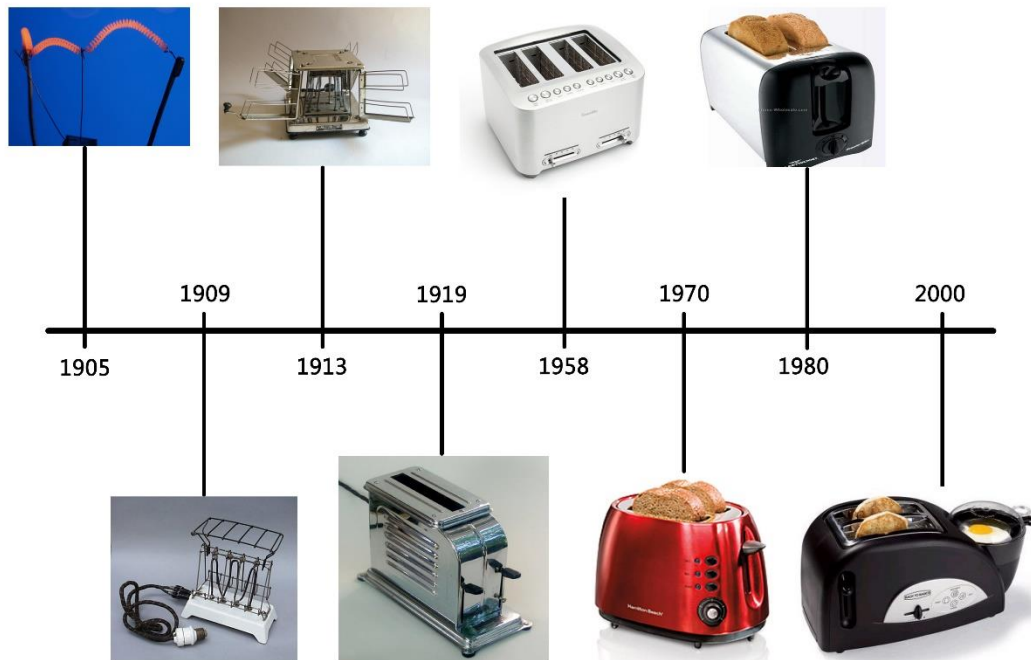


Figure 1 Evolution of Pop-up Toaster

In 1905, the nichrome wire filament was invented and used in the earliest form of toasters as a source of radiant heat. This wire filament has extremely low electrical conductivity and very high resistance.

In 1909, the implementation of nichrome wires was seen in the first-ever electric toaster. This appliance toasted only one side of the bread slice per cycle, and the slice had to be manually turned in order to toast the other side as well.

In 1913, a new feature got added to the previous version, i.e., automatic bread turning.

In 1919, the first-ever pop-up toaster got invented, called the Toastmaster. The lever would automatically spring back up once the toasting finished. Also, the nichrome wires would toast both the surfaces of the slices at the same time now. This version can aptly be called the 'father' of the new pop up toasters.

Since 1919, a lot more options for toaster designs have opened up because of the development of heat resistant plastics. Now, toasters are generally made up of stainless steel or such plastics as they remain cool to the touch even when exposed to high temperatures. Furthermore, features like four-slice toasting at a time, more full slots for thicker bread sliced and buns, crumb tray etc. have been added throughout the years. Since the process and mechanism of toasters have remained the same, people have taken to improve the aesthetics, form and ergonomics of the appliance.

In 2000, a pop-up toaster was designed that also cooked eggs along with toasting bread.

TINKERING

The tinkering of a Prestige 2-sliced pop-up toaster (750 Watts, 220-240 Volts) was done in order to understand its anatomy. This was done in order to better understand the working of the appliance, the structure and also the mechanism behind it.

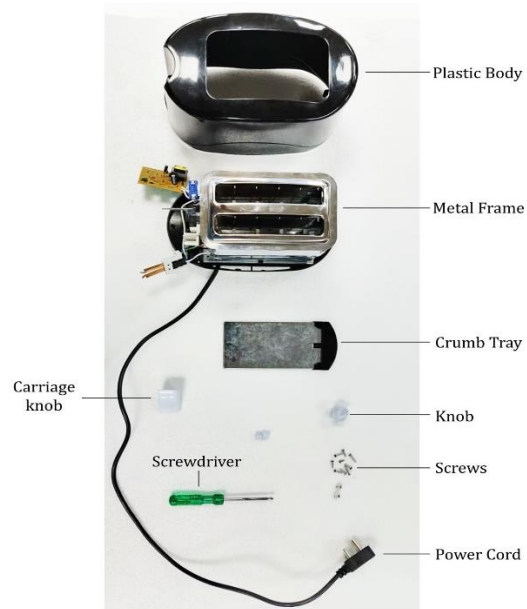
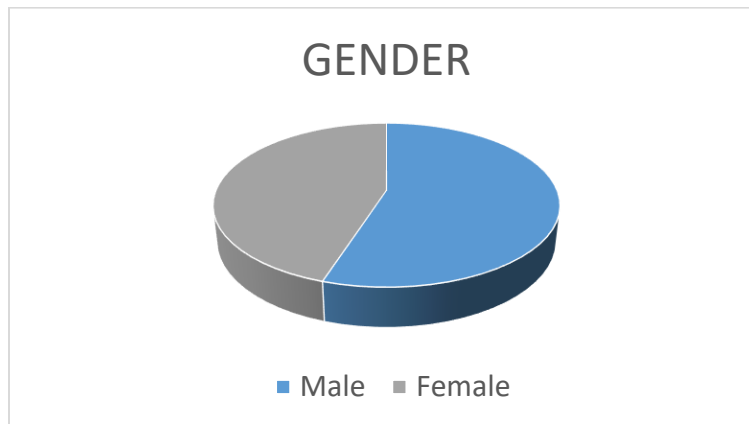
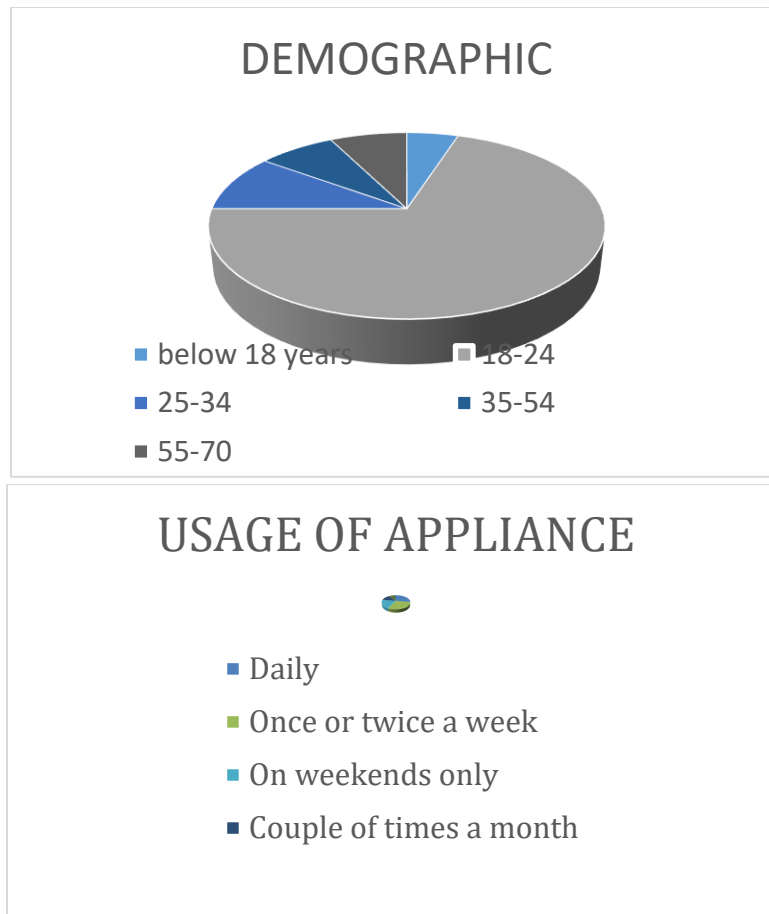


Figure 2 Components

SURVEY ANALYSIS





Out of the 50 or so people surveyed through questionnaires, around 55% were males while the rest were females.

Almost all demographics were surveyed although the majority were 18-24-year-olds, about 70%, followed by 25-34-year-olds, about 10%, and 35-54-year-olds and 55-70-year-olds, each about 7.5%.

About 67.5% of people were students, followed by 27.5% of people who were employed for wages either in govt. Offices or MNCs. The rest were housewives, retired people or those who are unable to work.

About 27.5% of people used the appliance daily, 50% of them used it either 1-2 times a week, while the rest either used it extremely rarely or not at all.

About 60% of the users had a preference for 2-slice toasters over 4-slice toasters.

Most of the people surveyed found it hard to clean the interior of the toaster of crumbs even though there is a provision of crumb trays as a lot of the crumbs get stuck in between the nichrome wires along the sides of the toast.

People use their fingers, majorly, to get the bread slices out of the toaster slots. When that fails, they go as far as using knives and forks to do the same, making them more susceptible to getting electrocuted.

People also invert the toaster and jerk them vigorously to get rid of the crumbs present inside of the toaster. Sometimes, the appliance falls while doing so because of a lack of grip while holding it inverted.

Also the plastic or stainless steel is shiny and slippery, and the bottom portion of the appliance does not follow the contour of their palms, hence, not providing places to grip it.

Burning of fingers, getting electrocuted, the toasters falling while inverting it trying to get rid of the crumbs and the toaster getting infested with pests are some of the bad experiences people have had with toasters.

Build quality (material of construction, mode of adhesion, robust built), aesthetics (looks, colour, shape, form), portability, ease of cleaning and safety were the aspects users paid a lot more attention to while buying a toaster.

TASK ANALYSIS AND SKETCHES

The task analysis of toasting slices of bread was done on an 18-year-old college student. The Task began at Unboxing the Toaster and ended at cleaning it after use. This was documented through pictures and sketches. The Task Analysis helped to empathise with the user and identify the grievances and pain problems the user had faced while using the appliance in real-time.

Table 1 Task analysis.

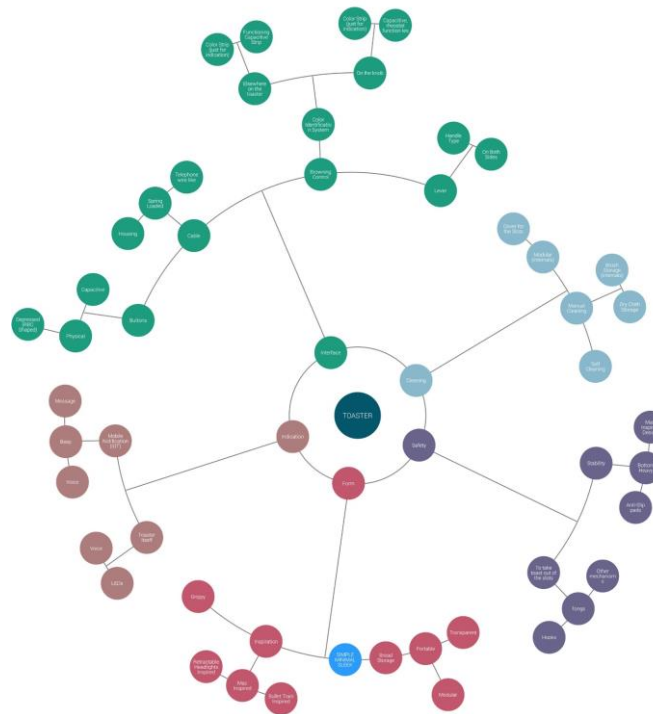
No	TASK	SUB-TASK	INPUT AVAILABILITY	ACTIVITY PERFORMED	OUTPUT GENERATION	DIFFICULTY LEVEL (*****) Easy →Difficult	SATISFACTION LEVEL (*****) Low→High
1.	Unboxing the toaster	Inspection of the box	The cardboard flap meant to aid in opening the box	Opens it using the flaps	The unveiling of the toaster	*	****
2.	Placing the toaster on a flat surface	Keeping it onto the slab	Flat surface		Toaster on the slab	*	*** A college dorm room has very little space; it is filthy and untidy. So, the toaster has to be portable.
3.	Plugging the toaster in the socket		The socket			***	***
4.	Placing bread in the		The bread slots	Tried to put the slices in the slots with		***	****

	toaster's bread slots			utmost precision but failed to do so		Always afraid of putting his fingers the slots and electrocuting or burning himself	
5.	Setting the browning level		The browning knob	Rotating the knob to achieve the desired setting		*	*** There is no indication of the actual level of browning of the bread corresponding the numbers present on the knob Hit and trial, which can be especially frustrating.
6.	Pushing the lever downwards		The lever	Pushes the lever down	The bread slices go down along with lever's motion. The LED lights up indicating the start of the toasting process	*	*****
7.	Waiting for the toast to be done					* He is on his phone, surfing the web and	*****

						listening to music	
8.	Post-Toasting activities	plugging the toaster off Taking the bread out of the slots	Popping up the bread slices	Uses his fingers to get the slices out and burns them in the process	Toasted bread slices	**** Burns his fingers and in turn throws the bread away	***
9.	Adding butter/jam to the bread slice		Toasted bread slices	Uses the knife to spread the topping	Buttered/jam bread slice	*	*****
10.	Cleaning the appliance	Cleaning the crumb tray Cleaning the inside of the toaster		Pulls the crumb tray out of the appliance, gives it multiple jerks, washes it with soap and water(occasionally) Flips the appliance upside- down and jerks it multiple times		****	* The crumb tray and the inside of the appliance never get thoroughly cleaned and free of crumbs. The appliance also falls many times because of lack of proper grip at the bottom of the toaster while the user inverts it.



Figure 4 Mind Map



FUNNELED PROBLEMS & SOLUTIONS

These problems were narrowed down from the above mind map based on them being the most recurrent ones across almost all the demographics surveyed. The probable solutions to these problems have also been written down alongside them.

<ul style="list-style-type: none"> • <u>FORM</u> – simple, minimal, sleek <ul style="list-style-type: none"> grip portable transparent inspiration – <ul style="list-style-type: none"> bullet train mac by apple retractable headlights of sports cars • <u>SAFETY</u> – stability - <ul style="list-style-type: none"> bottom heavy anti- slip pads - cover for slots • <u>CLEANING</u> - modular 	<ul style="list-style-type: none"> • <u>INDICATION</u> - LEDs <ul style="list-style-type: none"> timer • <u>INTERFACE</u> <ul style="list-style-type: none"> - buttons <ul style="list-style-type: none"> capacitive concave - cable management <ul style="list-style-type: none"> spring-loaded - browning control <ul style="list-style-type: none"> browning level identification - lever <ul style="list-style-type: none"> ergonomic handle on both sides of the toaster
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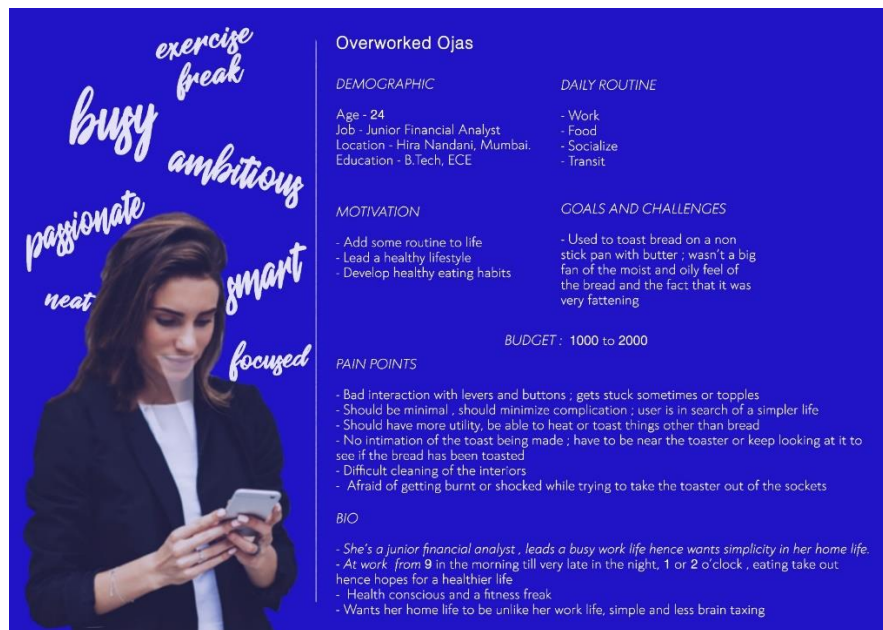


Figure 5 Persona

AREAS OF IMPROVEMENT

The following were the persona directed problems were decided to be worked on:

- Cleaning -

Easy, quick

- Safety -

If the toaster shocks, burns or injures the user in any way, he/she will throw it away rather than repair it

- Interface -

Less cluttered, intuitive and straightforward

- Better usability –

How easily the user interacts with the product

- Form –

Should be sleek, minimal and ergonomic

FINAL DESIGN BRIEF

- To create a SIMPLE, ELEGANT, INTUITIVE toaster design to make the user's home life unlike his/her work life, i.e., simple.
- Adding minimal changes and features, but those changes should be fundamental in elevating the functioning of the toaster in terms of its usability and interaction with the user.
- Make an ergonomic toaster that does not fall while trying to clean its insides by inverting it.

INSPIRATION FROM ALREADY EXISTING PRODUCTS

Inspiration was taken from three products majorly, which were the sleek design of bullet trains, iMac's CPU by Apple and the concept of retractable headlights as seen in old supercars.



Figure 6 Mood Board

CONCEPT GENERATION

After the research phase came to the ideation and concept generation phase. Inspired by the products above, many ideations were sketched out of which four concepts were further worked on.

GENERAL FORMS:

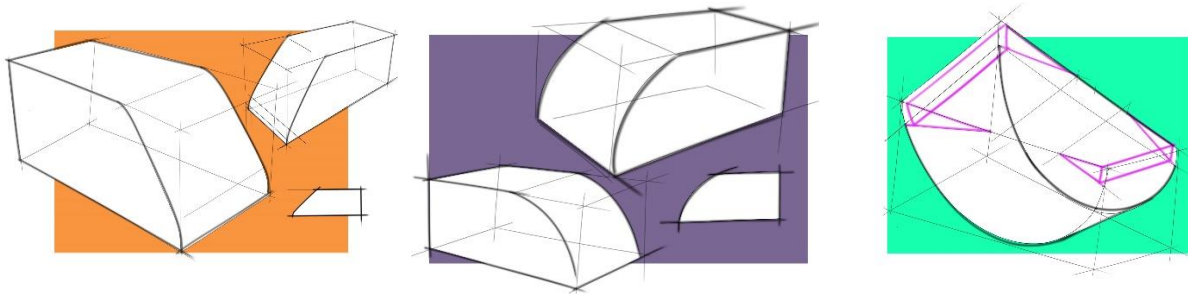
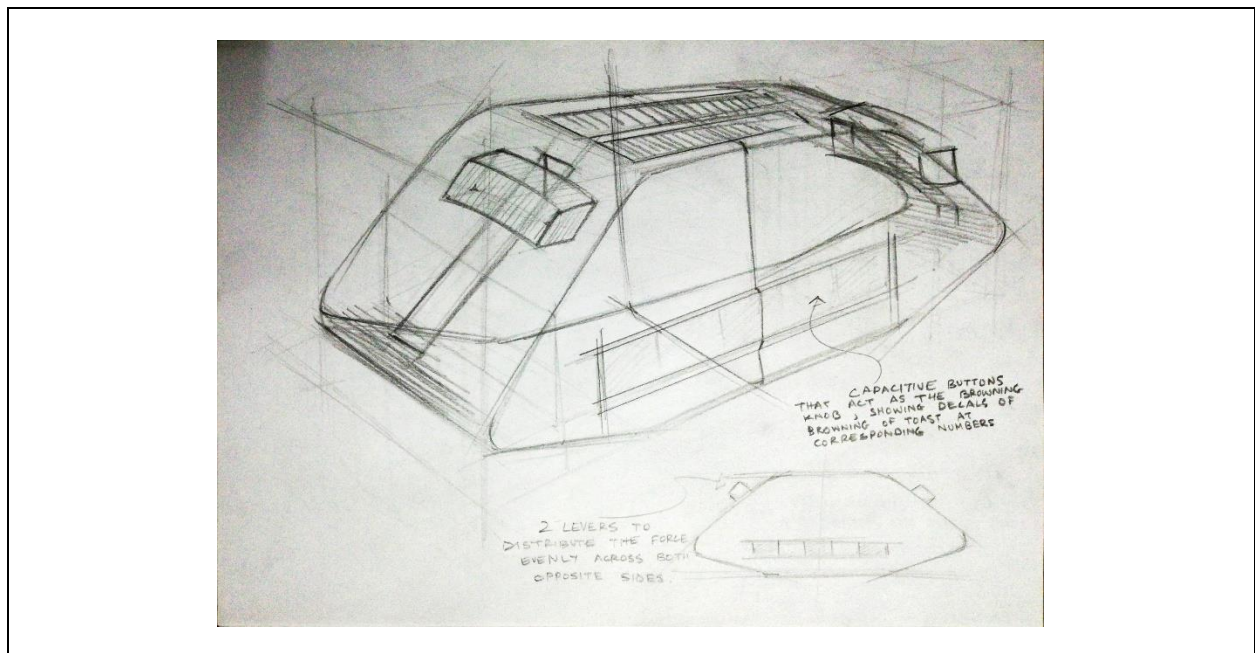


Figure 7 Form Exploration

Concept 1



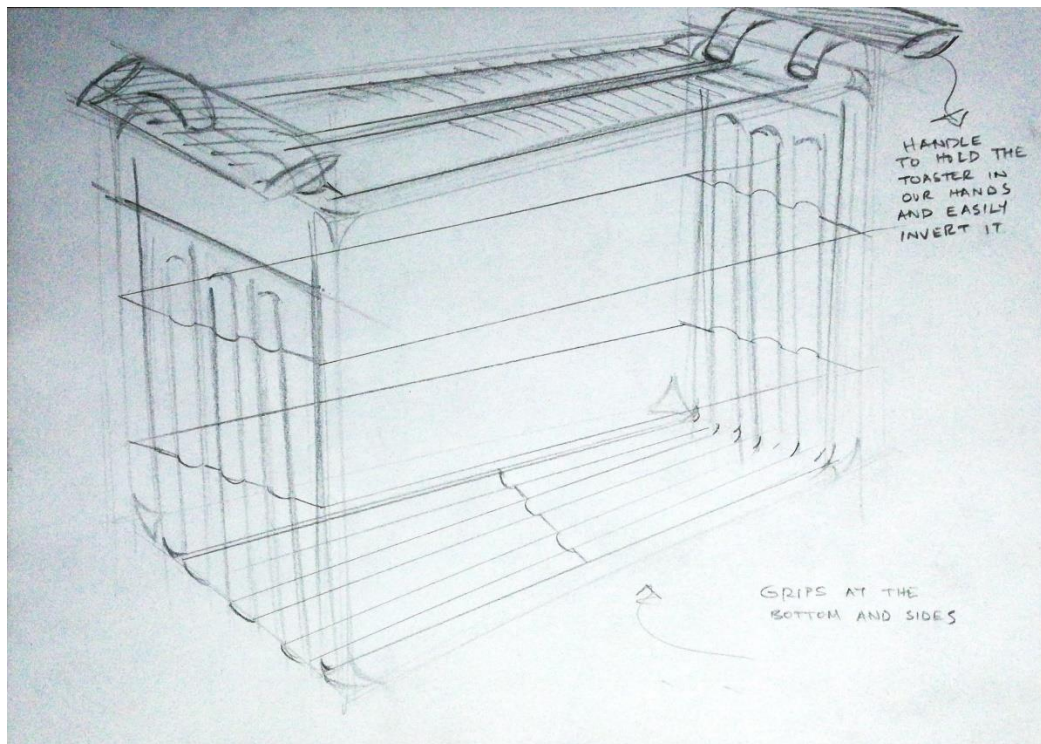
ADDITIONAL FEATURES

There are levers on either side of the toaster. This is done to distribute force on both ends of the toaster evenly, hence, less force needs to be exerted by one hand. Also, now that both the sides will experience the same force, the chance of the bread holder getting skewed from its place lessens considerably.

It also has a capacitive sheet across its side. This sheet has various decals of toasted bread slices corresponding to different browning levels, respectively.



Concept 2



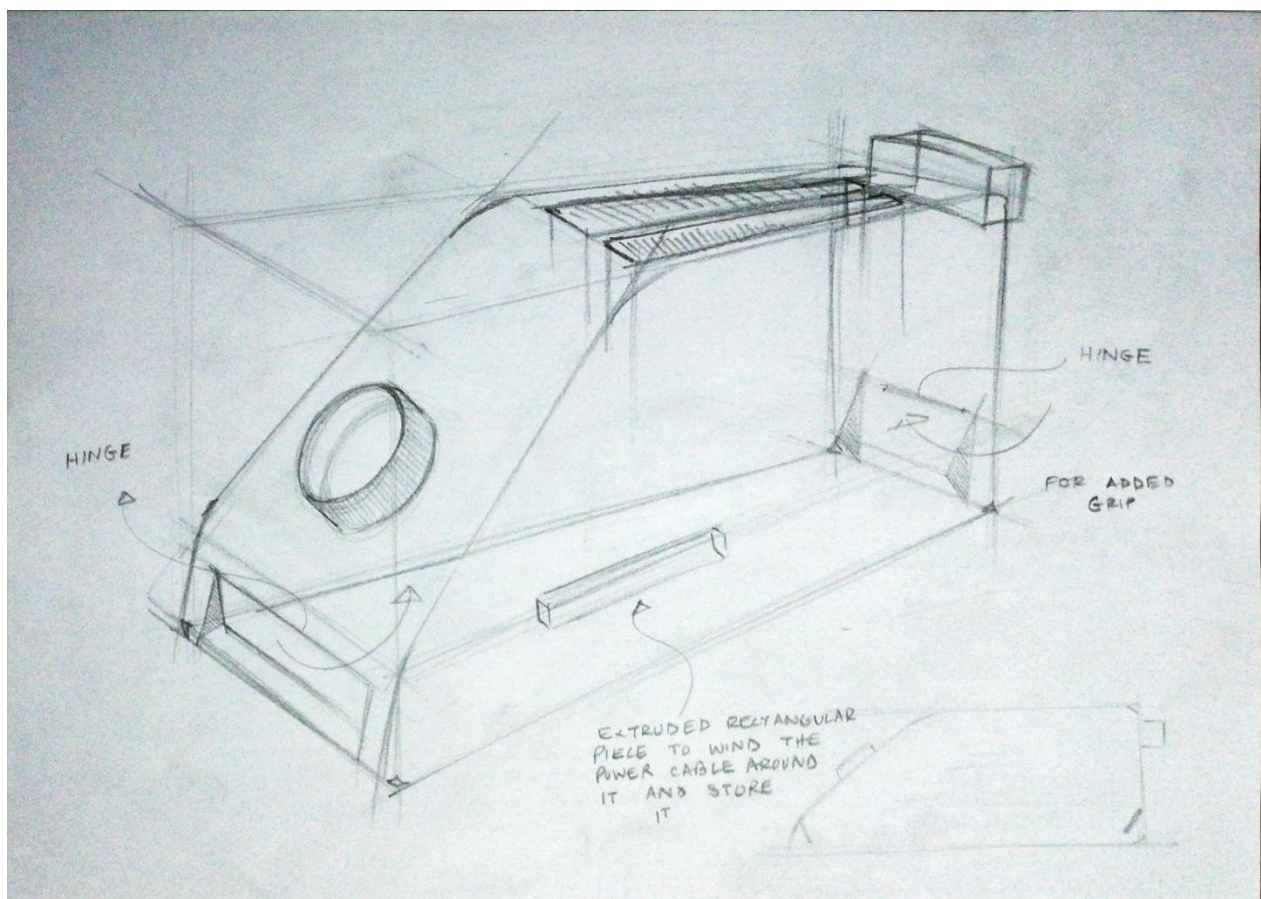
ADDITIONAL FEATURES:

The form of this concept is inspired by Mac Pro.

It has handles on either side for better portability and the user to easily be able to lift it and invert it to get rid of crumbs present inside the bread slots.

There are also grips both on the bottom and its sides to increase its stability and prevent it from falling or toppling, which was a significant concern.

Concept 3

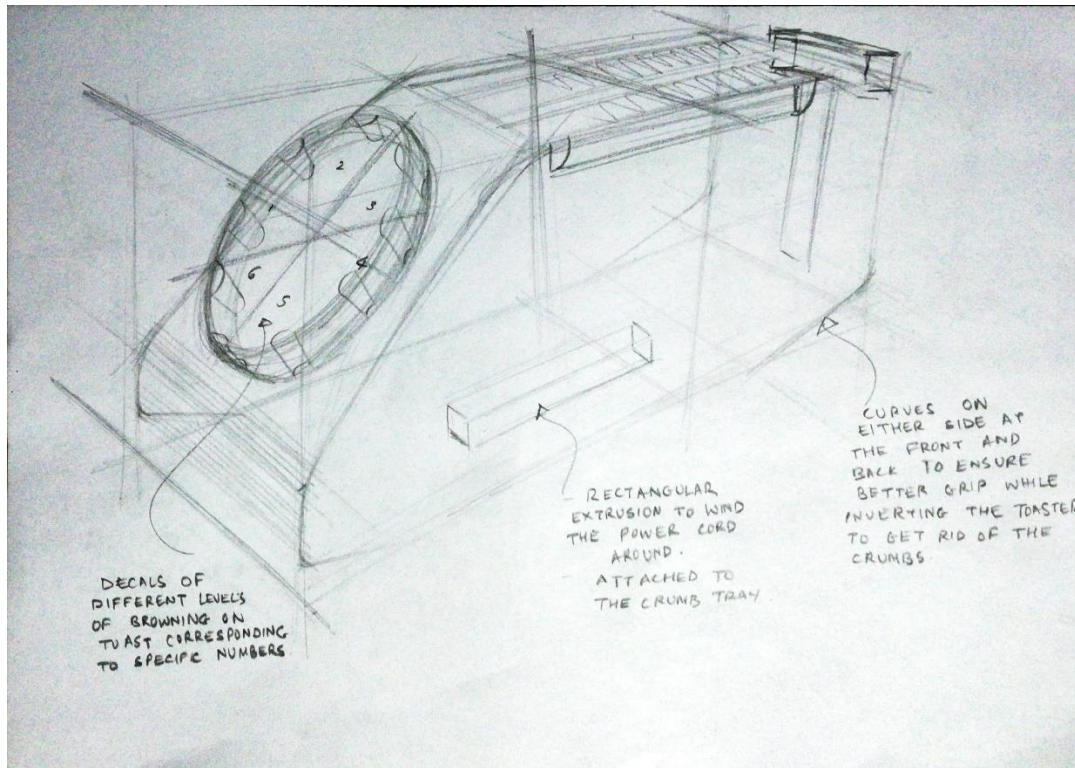


ADDITIONAL FEATURES:

There are hinges on both sides of the toaster which the user can push inside with the help of his/her fingers when trying to grip it in order to invert it and get rid of the crumbs inside. This hinge mechanism is inspired by the retractable headlights which were there in earlier sports cars. Also, there is a rectangular extrusion at the bottom around which power cord can be coiled.

FINAL CONCEPT

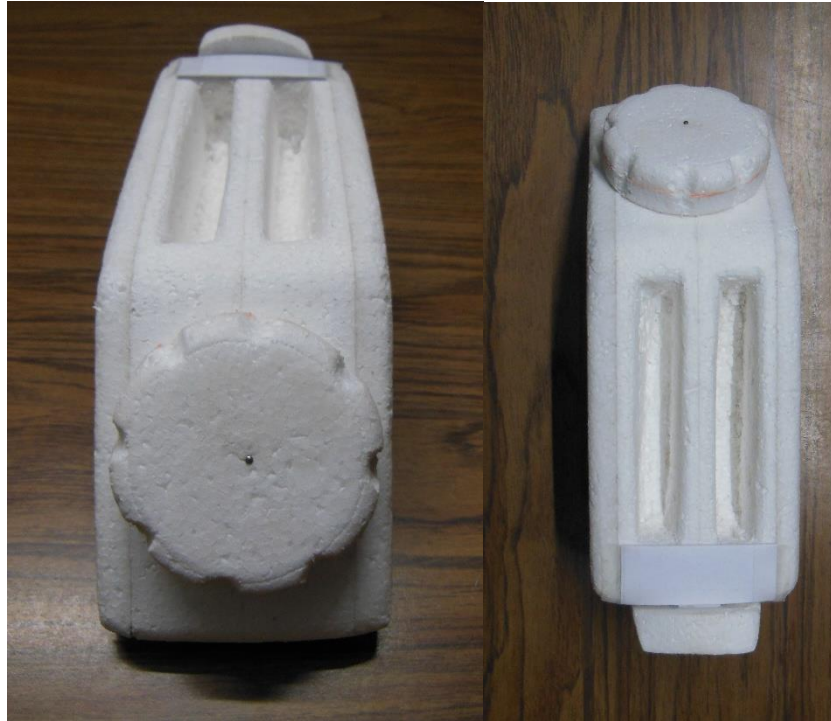
CONCEPT IDEATION:



THERMOCOL PROTOTYPE:

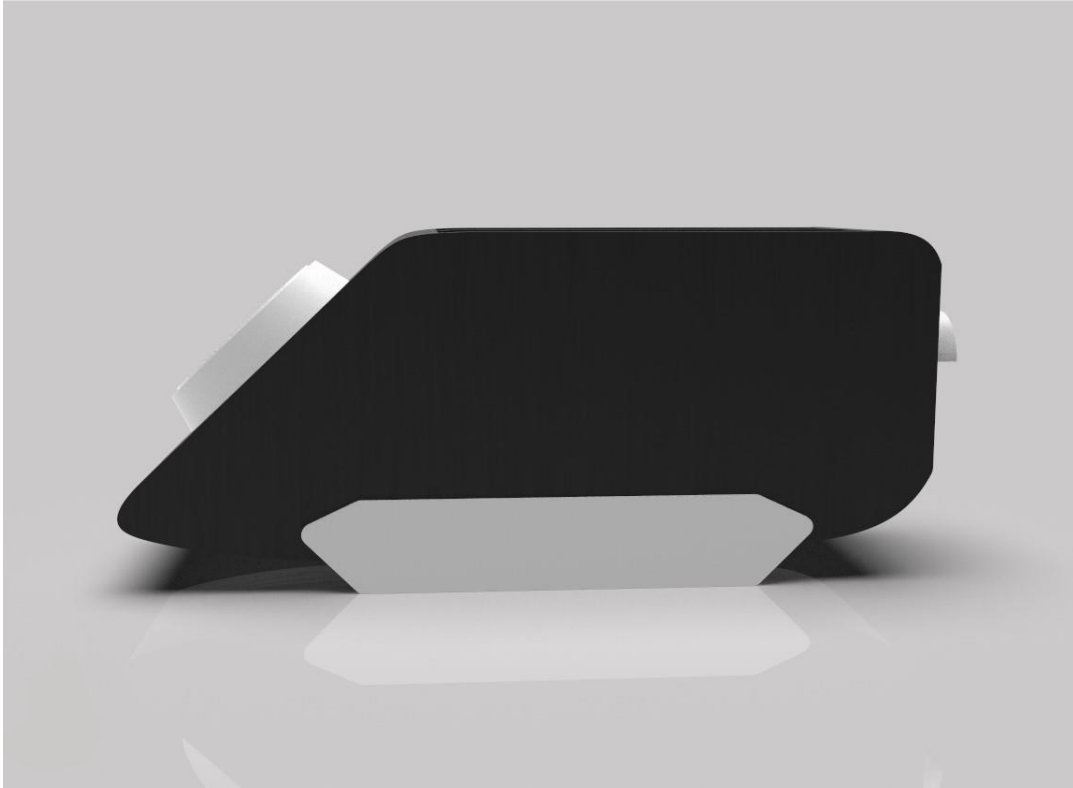
This prototype reflects the general form of the toaster and is not an extremely accurate depiction of the original design. The sleek one of bullet trains inspire the form.





CAD MODEL:





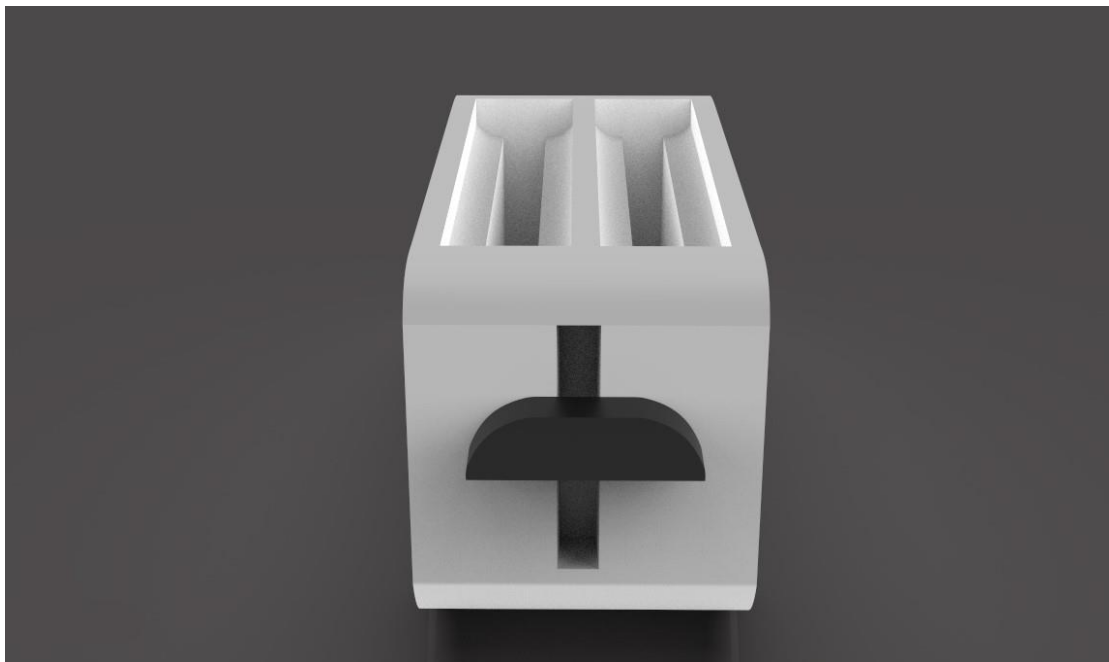
(Side view)



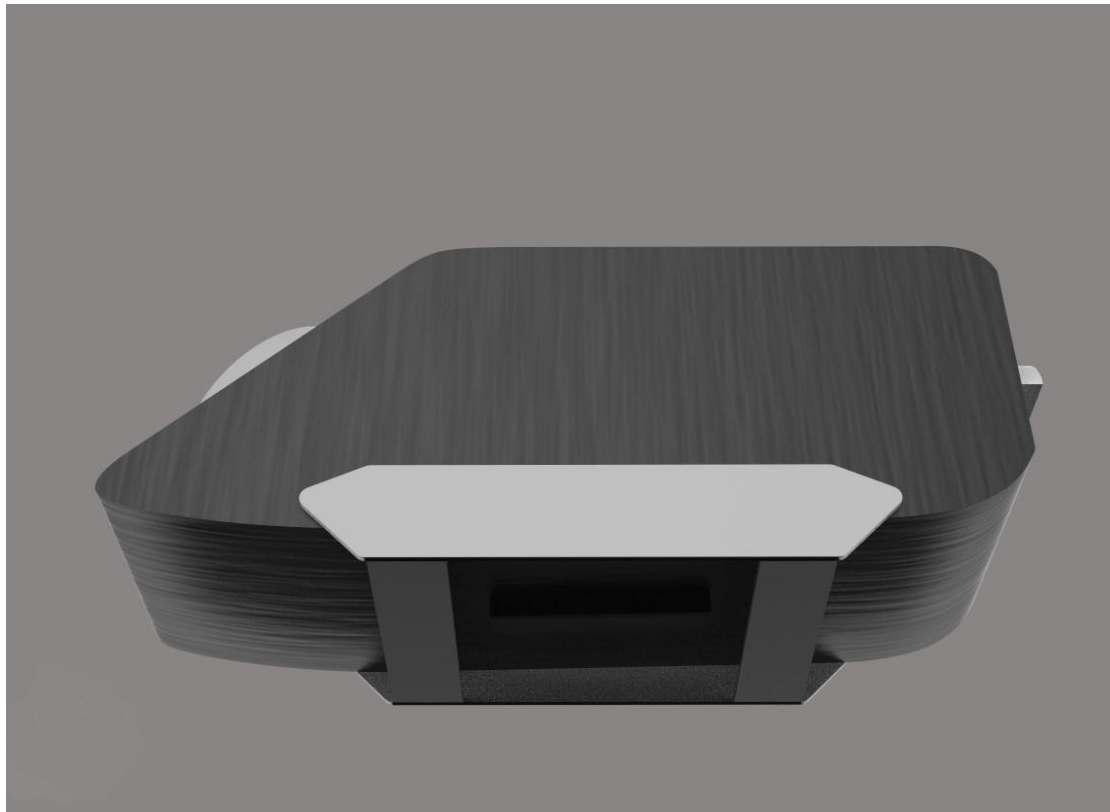
(Front view)



(close up of the browning knob)



(showing the fingertip shaped divots on either side of the bread slots)



(A rectangular from the bottom for cable management; two planks on either side at the bottom to support the hands when inverting the toaster)

KEY FEATURES:

- Rectangular extrusion at the bottom of the toaster, so, the cable can be coiled around it for better cable management and to reduce clutter on the kitchen marble top. (seen in Picture 6)
- The front and the back towards the bottom are curved and inclined to ensure better grip when handling the toaster.
- There are two slabs (as seen in Picture 2) at either side of the toaster which are essential in lifting up the main body of the toaster above the surface on which it is kept for the users to easily slide their fingers along the front and back of the toaster to lift it and invert it in order to get rid of the bread crumbs inside the bread slots and/or pests.

This space between the main body of the toaster and the surface ensures better handling of the appliance.

- The second function of the slabs is to hide the sight of the power cable coiled underneath the toaster and around that rectangular extrusion.
- There are two planks (as seen in Picture 6), joint to the slabs, at the bottom of the toaster that the hands then support instead of gripping the curved sides of the bottom that they grip initially when inverting the toaster.

Due to gravity, the whole weight of the toaster is supported through the placement of the hands beneath the planks when it is inverted and jerked vigorously to get rid of the crumbs and pests. This mitigates the chances of the toaster dropping down because of the lack of proper hold when gripping the bottom of the toaster.

- There are fingertip shaped divots/grooves on either side of both the bread slots to ensure that toast can be quickly taken out without getting their fingers burned or getting electrocuted. A lot of the people surveyed often used metal forks and knives and their hands to get them out.

When the toast pops out of the slots, it only comes out a centimetre or so at max, which is not optimal when people who have significant or thick fingers need to get them out. Hence, the divots.

- The browning knob is (as seen in Picture 1,3 and 4):
 1. Inclined at an angle, instead of it is perpendicular to the surface.
 2. More prominent and smoother, easy to rotate around its axis because of lesser torque requirement
 3. Has decals/stickers attached to which denote how the toast will look like once it completes browning at a particular level instead of digits from 1-6 as it often becomes a game of trial and error to get the desired browning on the toast that way and users get frustrated

All of the above points ensure a better user experience as the knob becomes more visible, usable and operable.

- The lever (as seen in Picture 5) is ergonomically designed to reduce the strain on the joints of the fingers.
- There is also a cover for the slots that will majorly reduce the risk of pest infestations.

- The material of the main body of the toaster is polypropylene plastic in a stainless steel finish except for the inside bread slots, its supporting structure and the lever mechanism, which is made up of real stainless steel.

The lever, the knob, the slabs and the planks are all made of white coloured polypropylene plastic.

Polypropylene has very high heat resistance.

CONCLUSION

This redesign was a result of the EDIPT design thinking system and the double diamond diagram. User-Centric Research was carried out to identify the pain points experienced by the user while operating the appliance. A final design was done after funnelling and sorting through all the ideation sketches and concepts created. The research included questionnaires, task analysis, interviews etc.

Principles of product design were taken into consideration to come up with a redesign that aimed at solving almost all the user-centric problems and improve its overall usability and interaction with the user.

Ergonomics and form were also some of the significant aspects taken into account.

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