AN INTEGRATED INDUCTION COOKTOP DESIGN

Integrated Product Design master thesis - Jeroen van Rijnberk

The way people are cooking is shifting. Were people have had gas hobs for a long time it is now changing to cooking on induction. Cooking on gas will be banned from 2050 on and is disappearing already. The way induction hobs are implemented at the moment is with a glass plate on top while still taking up space on the countertop like with a gas hob. Boretti thought of a solution to use another kind of ceramics able to have the looks of all kinds of materials like marble or nature stone. The concept provided by Boretti at the starting point of this graduation project was a standalone oven with this induction hob solution on top. The assignment was to create a version totally integrated into the countertop since the whole countertop can be made of the same ceramics.

To make a design that fits the needs of possible user groups, fit with the trends at the moment and in the future and suit the ways of living from 2021 on, an analysis was performed. Main conclusions were the shift in the marketing Boretti has to make., the change of the way people are living, house are becoming more open, smaller houses in cities are getting more expensive and multifunctionality of space with also making more connection between living room and kitchen are trends to take into account. This results in design changes in kitchen blocks, the need for better air circulation and purifying and multifunctionality in countertop space.

The analysis was followed by an ideation phase in which partial problems were tackled with different solutions. The topics ideated on were the user interface, multifunctionality cooking zone indications and the integration possibilities of a combined air extractor and air purifier. This ideation resulted in three different concepts were combinations of partial solutions were made.

After making three different concepts, two were combined. The new combined concept has an accessory bar that breaks up the countertop surface into a living part and a cooking part. This accessory bar has space for a range of simple accessories to things like a Boretti water tap. Personalisable Qi charging spots can be chosen while the consumer configures the countertop. To make sure the surface above the cooking zones can be used totally for other purposes, the control interface is not fixed. This interface is a smart rotational knob with which all cooking zones can be controlled.

The final concept can be seen on the left in which a kitchen island version is worked out in detail. The control knob has a light ring which refers to a gas burner and has haptic and visual feedback for the intensity of the selected zone. The main USPs are the multifunctionality and styling made possible with the material, an improved orientation during cooking and the smart knob.

Since there will be differences in the needs and configurations consumers will want to have for this concept. A range of product is suggested to Boretti around this concept.

CONTEXT

Before diving into the analysis, at first the context is introduced containing the company being Boretti and the basics on how cooking on induction works.

ANALYSIS

To be able to define a scope for the ideation phase, define main drivers and find search areas, an analysis on different topics like housing and kitchens was performed.

MAIN DRIVERS

To create a design fitting the targeted user groups , taking into account the current developments and suit Boretti as a company, a list of requirements is created with the main drivers being the most important ones.

IDEATION

This section is about diverging and creating many (partial) solutions within the scope op the project. Ranging from the functions of the worktop to the way cooking zones are indicated.

CONCEPTS

Different combinations of partial solutions were made to create different concepts and form total solutions fulfilling the main drivers and suiting a different target group.

EMBODIMENT

To make the concept work as intended, further development is needed. The looks have to be worked out, the user interaction, all the components needed and finally the product architecture and materials and production.

PRODUCT PLACEMENT

Since the final design actually exists of multiple products to support it, a product placement and strategy is suggested to Boretti for future developments.

PRODUCT PRESENTATION

To show the final design in full glory, some final renders with explanation can be seen in this section..

VALIDATION

To evaluate the final design on the expected and desired outcomes, it is tested on the main drivers and requirements. If needed, further development is suggested to meet them.

CONCLUSIONS

To sum everything up and give answer to the questions asked in the original assignment, a conclusion was written.

This report is about the development of a new way of cooking on induction. Instead of using glass on top, an other type of ceramics called Gres-porcelain is used which can have the looks of different kinds of stone, marble and other materials. The case owner for this project is Boretti which is a company originated in the Netherlands and inspired by the Italian lifestyle. Jacco Bregonje, who designs everything for Boretti indoors, was inspired by the marble from Carrara in Italy some years ago and developed the first concept. Jacco Bregonje was involved as a coach during this graduation project as well. Since he is not working internal in Boretti, the product manager of Boretti Nico Admiraal, was involved in the project too. At last, two coaches from the TU Delft were involved being Erik Tempelman as a chair and Martijn Haans as a mentor.

The project will at first capture the context of the project being Boretti as a company and cooking on induction. This is followed by an analysis section to explore inside the scope with examples like housing and kitchens. Next, an ideation phase is performed followed by making concepts out of combinations of partial solutions. Then, an embodiment phase was described on how the looks, user interaction and product architecture with materials will look like.

At last the project was put into the bigger scope to show Boretti what these developments can mean for their future product portfolio and strategy. Everything is validated, concluded and recommendations are given in the end.

At the start of this project an assignment was formulated to define the focus and scope. The starting point is a concept called Carrara, which is already in development by Boretti and can be seen in figure 1. Carrara is a place in Italy were specific kinds of marble come from. This revers to the main USP of this concept, being the use of a different kind of ceramic on top of an induction hob to be able to give other looks to it like marble for example instead of the traditional black glass. The version already in development by Boretti is a stove with oven combination, which has been prototyped. The next step is to make a version that is totally integrated into the countertop of a kitchen. A first idea on how to do this was created by Boretti already and can be seen in figure 2. At the start of this project this was only a render and there were no prototypes or product architecture yet.

The focus for this graduation project was to research how the product must be integrated and develop an user experience around it suiting targeted user groups. This use of material brings many new opportunities and can influence the whole way we think of cooking on induction and even how a countertop or kitchen should look like. Those opportunities are of big importance to explore in this project and then develop to a product design which also considers the trends and needs. For a full description see the project brief in appendix A.

Figure 1: Original concept of Boretti

Figure 2: First ideas on integration by Boretti

To give direction to the design process and fulfill the assignment, multiple methods were used. The overarching method to give an overview of the whole process is the double diamond. In figure 3, an illustration can be seen of what this looks like. The diamonds each start with diverging and end with converging. The first diamond is all about analysis, starting with finding a lot of information after which the most important findings have to be lighted out and can be used to define requirements for the design and find the first directions for the ideation phase. The second diamond is about ideation. Starting with diverging again followed by selecting the right ideas and make it into one product design.

Starting with the analysis phase, multiple methods were used. To find certain trends, a DEPEST analysis was performed. A SWOT analysis was done to explore the company. Interviews were performed with different kinds of experts and possible user groups. Personas were created for possible user groups. And at last, desk research was done looking into new built projects of housing, looking at the current market and so on.

For ideation, brainstorm sessions were done. Looking at reference product and getting inspiration from other products and kitchen designs was a main part of this as well. Creative sessions with other kinds of designers were performed. At last digital sketching and CAD modelling were used to visualize and explore different ideas.

The conceptualization and embodiment phases consisted of small diamonds comparable to the double diamond described before. The problem was broken up into different pieces on which could be diverged and later on converged. Interviews with experts helped making choices and selecting the right possible solutions. CAD modelling was used to tweak the looks of the design and create product architectures. 3D printing and other prototyping was used to evaluate sizes and simulate different functions of the design.

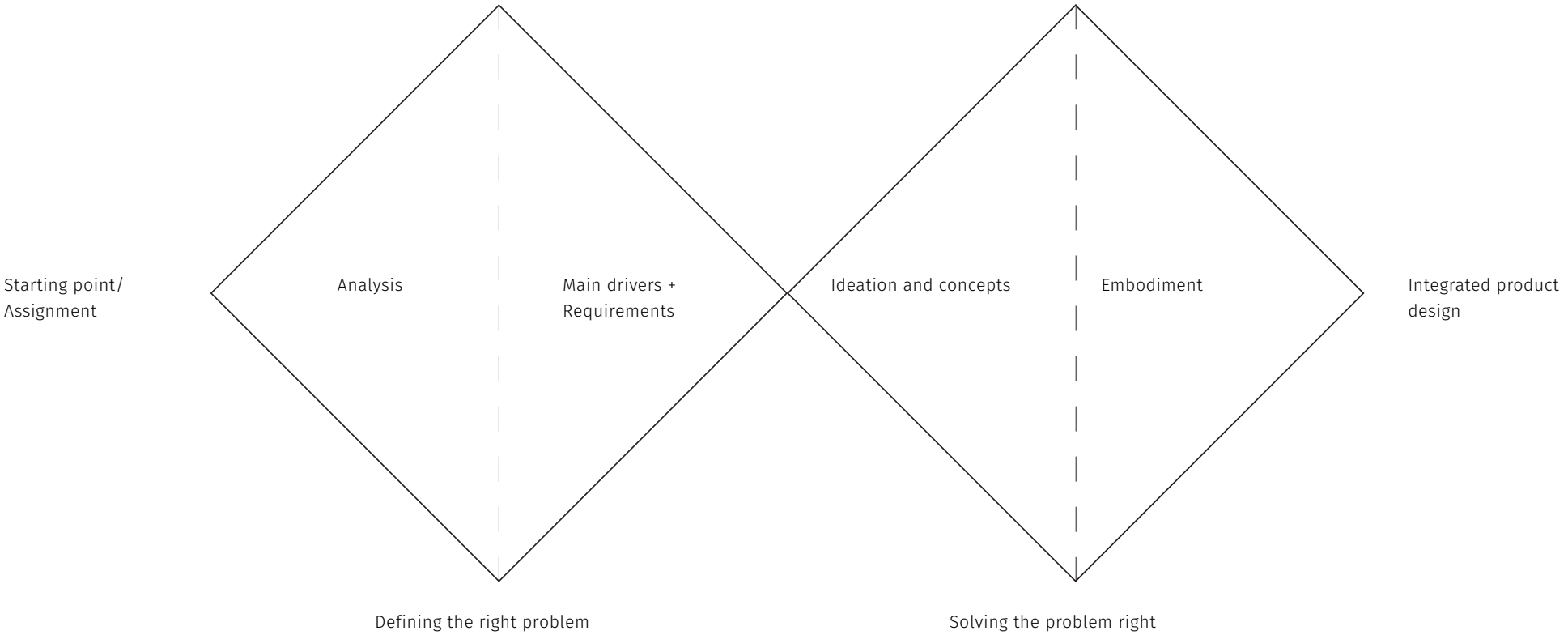


Figure 3: Illustration double diamond

Before diving into the analysis, at first the context is introduced, containing the company being Boretti and the basics on how cooking on induction works.

Multiple factors and developments provide reason of existence for this project and make it valuable to execute. At first, it fits the values of the company which is Boretti. Next to that, it plays into the fact that cooking on induction is getting more popular and will even be needed in the Netherlands for example, since cooking on gas is disappearing during regulations of the Dutch government (Rijksoverheid). Next to those main driving forces, there are also multiple trends and developments that support the needs of this project being executed. At last the specific used material is the actual main driving force of this concept which will be elaborated on in following chapters. The following will mostly describe the company and cooking on induction. Other factors will be covered in the analysis section.

Boretti is all about living the Italian lifestyle and being passionate, both in style and the user experience.

Values

According to internal strategy presentations, Boretti has many important values (Boretti, 2019) which can be divided into different categories like emotional values, design values and product/service values. What comes most forward are passion, authenticity, Italian origins, being inviting, Famiglia, inspiring and high quality.

Strengths & weaknesses

Multiple characteristics separate Boretti from their competitors and can be seen as their strengths. Starting with their strong brand name. When looking at houses for sale, if there is just a Boretti stove, it will be said there is a Boretti kitchen in the house to attract buyers since it is a well-known name that stands for high quality. Hereby coming to their next strength, which is the high quality and solidity of Boretti products. Furthermore, Boretti has a large product portfolio and offers about every possible kitchen appliance one might need. Something that separates Boretti here from competitors that have a large product portfolio as well, is that Boretti offers everything for the lifestyle like their own olive oil for instance. The fact that Boretti does not have its own factories can be seen either as a weakness or a strength. On the one hand they are more dependent on other parties that have to produce for them. On the other hand they are not committed to a certain production method which makes it easier to innovate. The high quality and the brand Boretti has built does come with a price tag. Therefore possible user groups might be smaller but on the other hand will be more committed as well. See figure 4 for a typical Boretti oven. The strengths and weaknesses described are a result of a SWOT analysis. Since this project is not about creating a new strategy for Boretti, this SWOT analysis was performed quickly with the goal to get better insight in the company and use that while designing. The complete SWOT analysis can be found in appendix B.

Figure 4: Boretti oven fromt the Maggiore collection

The type of hob that will be used for this concept is induction. Like said before, gas hobs will not be accepted in the Netherlands from 2050 on (Rijksoverheid). The market for induction hobs is not only large in the Netherlands. The market is biggest in Japan, followed by western Europe countries like France and Germany and are then followed by North America (appliance DESIGN, 2018).

Working principle

The way induction hobs work is as following; An electromagnetic field originated by coils that are powered through electronics heats up the bottom of a conductive pan. In this way, the induction hob is not a heating element itself and at first only the pan gets hot. As a result of the pan getting hot, the glass ceramic plate in between the electronics and the pans will heat up as well. See figure 5 for a schematic overview of the working principle of induction hobs.

Cooking zones and flex zones

Most induction hobs have at least some cooking zones which are similar to the use of gas burners in a gas hob. Often those cooking zones can be combined with one or multiple flex zones as can be seen in an example of ATAG in figure 6. Those flexzones often detect whether there is a pan and were it is using pan detection technology. In this way you can put different kinds of pans on it or even an induction compatible grill plate that covers the entire flexzone.

Pros and cons of induction hobs

Using an induction hob versus a gas hob or an ceramic hob has different pros and cons. One major pro on which it is better then both gas hobs and ceramic hobs is energy efficiency and sustainability in terms of the environment. Since only the pans themselves are heated up, less energy is needed. A pro versus gas hobs in particular is the cleanability since it is just one surface that needs to be cleaned. Also the heat up time to boil water for instance is much shorter with induction. Since the induction hob will only get hot when pans are on it that heat up, it is also safer then ceramic hobs which will heat up also when nothing is on it. There are some cons as well with induction cooking. The first one is the need of special pans made from the right material to be able to cook on it. Next to that, using a wok is harder since the heat comes only from the bottom and not the sides which is the case for gas hobs. Also, the visible response is less than with cooking on gass were the actual flame is visible.

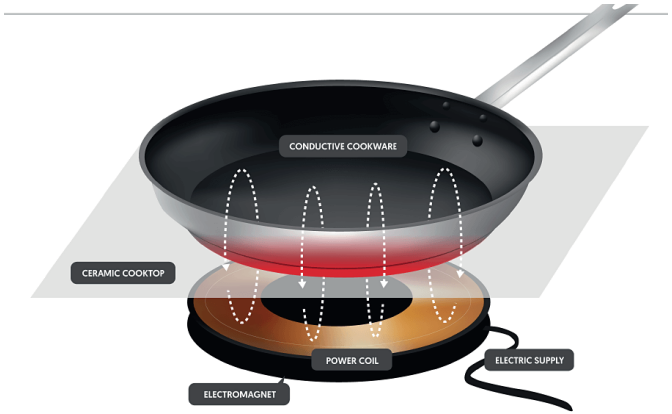


Figure 5: Schematic overview induction principle

Figure 6: ATAG induction hob with flexzones

To be able to define a scope for the ideation phase, define main drivers and find search areas, an analysis on different topics like housing and kitchens was performed.

To get a better image of the living conditions, styles and house types, research was performed with the goal to provide deeper understanding in house types, the ways people are living, the specific needs per situation, give inspiration and help defining possible user groups. This research was performed through different forms, being: looking at three new building projects (Little C, Amsterdam Vertical and Hefkwartier), retrieving specific numbers on house types in the Netherlands, reading two modern and contemporary architecture books, looking at inspiring projects in two documentaries and reading articles on certain developments about the ways people are living together.

House types

Especially in the Netherlands, there is a classic division of house types. Those types are: apartments, rijtjeshuisen (best translated as terraced houses), twee onder één kap (best translated as two houses under one roof) and detached houses. From those types, especially apartments are getting more expensive and are most popular in the bigger cities. (CBS, 2015) When looking past those classic house types while looking at new building projects, it can be seen that there can be a modern division of house types with each their own qualities and needs. Think of lofts, studios, maisonnetes and penthouses (see appendix C). Since lofts are consisting of open spaces, for this house type ventilation is important as well as furniture and the kitchen being a connection between different areas. When speaking of ventilation, it is also important to notice that at least in the Netherlands for new built houses better ventilation systems are installed in most cases (RVO, 2014) and recircular air extraction in kitchens will be the new standard. For the smallest house types like small apartments or studios, a good use of space is everything. For this, furniture being modular or multifunctional can be essential. A good but extreme example on how this can be done is the apartment design of Gary Chang in which the apartment consists of just one room which is completely modular and can be made suitable for many different occasions (see figure 7). For the larger houses like a classic detached house, multifunctionality can be less important but orientation might be an important point.

Way of living

Just like for the house types there are the more classic settings like living alone, with a family or a couple. They all bring different desires, possibilities and limitations. When living alone, multifunctionality and personality becomes more important. When living with more people using the same space and function after each other or at the same time will be the case. There are also new ways of living alone or together. Shared living is one of those examples which is getting more popular both in Europe as in other parts of the world (Sharedlivingenvironment). With this way of living, most people have their own bedrooms. However, other facilities like large cooking and eating areas which are working spaces at the same time have to be shared. The space adapting to the needs of all the different inhabitants is of great importance here. Next to that, more people are working from home and this combined with living in a studio for instance makes it true for this situation as well that the space has to be able to support the needs of the user at different times of the day. More specific needs per group are discussed in the users section of this chapter.

Open spaces

Looking at both the mentioned house types and the ways people are living, one thing is really coming forward. The living areas are becoming more open. The kitchens are becoming more part of the living rooms and all rooms are connected. This is especially true for lofts and studios. A good example of this can be seen in figure 8 which is an example render of one of the new built projects that were analysed. The kitchen uses the same material looks as the living and is really part of it. Figure 9 shows an example of a floorplan in the Little C project.

House type vs. kitchen type

There are no rules for kitchen types that have to be combined with certain house types. One thing that is noticeable in new building plans is the upcoming of the kitchen island which seems to be suited for about every house type apart from studios, see the floorplan example of a penthouse on the right in figure 9. Obviously the smaller the house or apartment gets the change the kitchen is smaller and for an example a straight kitchen without a kitchen island or a L-shape.

Opportunities & limitations

Different house types combined with a certain way of living will ask for different needs and have different limitations. The need for different situations of having a space or furniture that can serve multiple purposes or be space efficient combined with the possibilities the used material has to offer is a serious opportunity. Next to that, the different orientations that are needed for different settings need to be taken into account while designing for certain user groups. At last the kitchen is becoming more part of the living area and the other way around in modern house layouts which needs to be seen back in the design. The amount of space and the budget are the limiting factors when it comes to the house type and way of living.

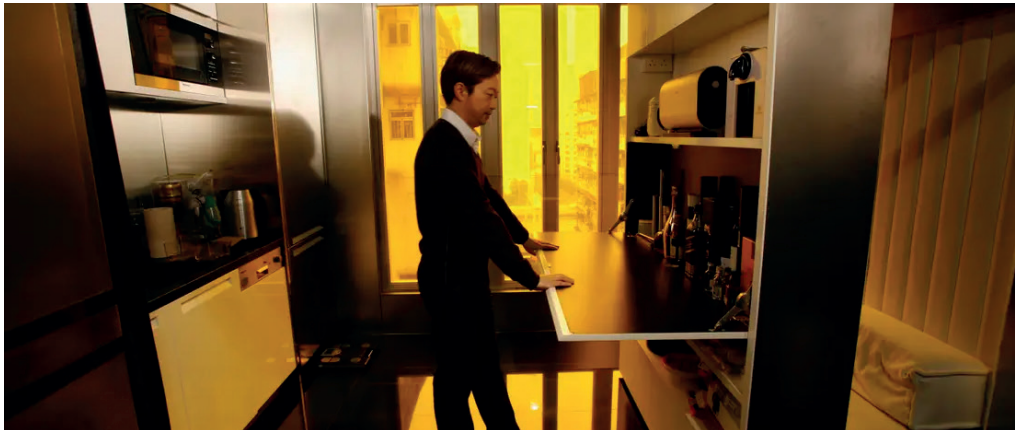


Figure 7: Adaptive space from House documentary

Figure 8: Example render Lttle C project

Figure 9: Example floorplan Little C project

The hob is one of the most important parts of the kitchen. The other way around, to design a good hob, it is essential to have knowledge about the rest of the kitchen as well. The goal of this research is to get more knowledge on the current kitchen trends, inspiration on kitchen designs and insights about the developments of hobs and other kitchen appliances on the market. To get this information, an interview with an expert, analysis on kitchen designs of kitchen stores, concepts of modern Italian kitchen designers (Boffi, Arclinea and MaronneMesubim) and analysis on competitor product portfolios was performed.

Kitchen types

Starting with the basics, certain standard kitchen layouts can be recognized. Those basic kitchen types are a straight kitchen, U-kitchen, L-kitchen, open and closed kitchens and kitchen islands (Keukenconcurrent). Looking at different modern Italian kitchen designers (appendix D) and inspirational magazines of kitchen retailers, it is noticeable that kitchen island are getting more popular and become the center of many kitchens. These kitchen island in many times also serves as a place to sit at, connecting the eating area and or the living room more with the kitchen. Interesting to notice is that often a kitchen layout is not one of the basic types but there are many variations. Think also of a breakfast bar or combinations between the standard kitchen types. Different combinations are being made of standalone appliances and built in ones. In the end the options are countless. To make the kitchens ergonomically responsible, standard heights, counter top thicknesses and extractor hood heights were explored in appendix E.

Style

Stylewise it is hard to make clear divisions since the designs are becoming so slight in variations. Terms like Urban, clean, minimalistic and country come to mind for instance but many kitchen designs are in between different styles and cannot be given a certain hard name tag. What is noticeable in the bigger figure is the use of rough and natural (looking) materials that are used in different ways in a lot of those styles. Think of marble, concrete looks and metal. Next to that, handle less closets are becoming a thing. Looking at the modern Italian kitchen designs, often combinations of those clean natural looks are made with sometimes a bold statement in it which is contradicting to the rest of the kitchen (see appendix D).

(Induction) hobs developments

Taking a look at both gas hobs and inductions hobs, modularity is seen back more and more. A good example is the Gaggenau 400 series in which you can choose many configurations of types of hobs, integrated air extraction and add-ons like a teppanyaki plate. See figure 10 for an example configuration. Many brands offer at least to combine either a gas hob or an induction hob, coming in different sizes, with a different amount of cooking zones with the possibilities of a teppanyaki plate and integrated air extraction. One of the things that came forward from the interview with an expert (appendix F) is that consumers often chose for a combination of cooking zones and one flexzone when it comes to selecting an induction hob. The choice to go for an induction hob instead of the traditional gas hob is getting more popular according to the expert as well. This is not only true for the Netherlands but also for countries like Japan (appliance DESIGN, 2018). Looking at the more modern gas hobs they sometimes are directly integrated in the countertop as can be seen for example in figure 11 which is a design of Boffi. Up until now, this was not possible yet with induction hobs due to the need to use a glass top layer. It is not only true for modular hobs that the integrated air extractors are getting more popular. Companies like Bora are building their entire brand around it. A last thing the expert told me about hobs is that she was waiting for an induction hob that has rotational knobs to control it instead of the touch buttons most induction hobs are currently using.

Integration

Integrated kitchen appliances are an important factor of modern kitchens. Everything is possible to buy built-in like ovens, steam ovens, microwaves, coffee makers, hobs and so on. An example suited more for the serious home cook is the Chef Sign from KitchenAid as seen in figure 12. In modern kitchen designs like a semi-professional one from Arclinea which can be seen in figure 13, multiple functions are built in in a flexible way with certain elements in the center. Another good example is the designs from MaronneMesubim in which everything you need is integrated into one kitchen block. Things like a sous vide installation for instance.

User interface

Looking at user interfaces of built-in kitchen appliances there are multiple possibilities on the market at the moment. Think of touch and tap interfaces which are mostly used for induction

Figure 10: Gaggenau 400 series

Figure 11: Boffi kitchen design with integrated gas hob

Figure 12: KitchenAid chef sign

Figure 13: Arclinea kitchen design with integrated appliances

hobs, turning knobs for gas hobs and touch screens for ovens as examples. More innovative interfaces like a magnetic knob without a fixed location like Neff is using, can be interesting to implement.

Air extraction
Another thing that is evolving from the classic form we know to new different forms, is the air extraction. Like explained before one way is that an air extractor integrated in the counter top is becoming more of a thing. Another noticeable development is the air extractor becoming a piece of furniture. Good examples for this are Berbel and WaveDesign (see figure 14 for an example of WaveDesign). Especially with the use of recirculation, the air extractor does not have to be directly attached to the sealing anymore. Even a lamp can become a lamp and an air extractor in one just hanging with strings underneath the sealing.

Food
Looking at trends and developments in the food and cooking industry, it can be seen that online companies delivering either groceries or ready to eat foods are becoming bigger. Delivering meals might be seen as a bad development since people will cook less. This might not be the case for this project. Most people that are cooking just sometimes still need a hob but would like it not to be there all the time. This is exactly what is made possible with the concept being developed in this project.

Opportunities & limitations
Since Boretti now has the possibility to make the whole countertop with their induction hob, the trend of adding more integrated functions can be a large opportunity. While producing the whole countertop, different Boretti products could be integrated in a very stylish, functional and well thought way. Examples for this are the earlier named things like Teppanyaki and sous vide components. The popularity of flex zones also has to be taken into account. Especially since it now can be totally hidden in the counter top. The extra costs that flex zones have versus cooking zones do have to be evaluated. Also modularity of the amount of cooking zones can be interesting for this project. Depending on the user interface and interaction, it could just be a matter of installing different possible combinations of prefabricated modules with cooking zones or flex zones underneath the ceramic countertop.

Looking at air extraction, multiple things have to be considered. Integrated air extractors are still in doubt for a lot of people if it is actually working as well as traditional extractor hoods. Both the expert that was interviewed as people inside Boretti confirm this distrust. Also an integrated extractor hood could mean the countertop is not one peace anymore since the extractor will be visible in some kind of way. On the other hand, it might be an opportunity to play in to the earlier named multifunctionality and integrated design trends.

A separate extractor hood might give the opportunity to have the countertop and extractor hood in the same material and style and be as a reflection of the counter top and make the kitchen as a whole a stronger design.

One thing that in all cases has to be seriously considered is the use of recirculation filters since this is becoming the new standard in houses and gives more freedom for the design since it does not have to be attached to something that leads the air out of the house anymore.

The different discussed styles that can be seen back in modern and Italian kitchen design have to be considered while designing the final looks of the product and while choosing the right kind of ceramics producer.

Limitations will mostly be the patents that other companies already have like Bora for instance and the probable needed cooperation's with other companies.

Figure 14: Air extractor and lamp in one from WaveDesign

To get better understanding on the final product placement in the market and the possible limitations or opportunities certain choices might bring with them, analysis was done on competitors, pricing and possible selling channels for the concept.

Competitors

The current competitors and the competitors for the concept that is developed during this project will be different. For now, other brands with induction cooktops like AEG, ATAG, Bertazzoni, Siemens and countless others are all competitors for Boretti with its own induction cooktops (See appendix B). Since the new concept will have the induction integrated in the countertop of a kitchen, the whole countertop or even a part of the kitchen will be the thing that is sold. In this way the product is not very similar anymore to normal cooktops and will create and enter a new market. Partly it will now also have to compete with countertop producers. Other parties like Hubstone and RAKceramics are working on something similar which might mean they will become new competitors. In figure 15 the current concept of Hubstone can be seen. There is also the opportunity for a collaboration between them and Boretti which is already being considered by Boretti at the moment. At this early phase going for collaboration might be the smartest since then technologies can be shared to develop the product quicker and better. Next to that, when working together it can automatically mean to be the only one with such a product on the market and have no competition. Downsides might be that concessions have to be made to fulfill the needs of all parties.

Pricing

Currently, respective to competitors, Boretti is in more expensive part of the market. With induction cooktops of 1.199 euros compared to a similar size cooktop of AEG that is sold for 675 euros. With this new product, coming with new technologies and the expense of new materials this will mean that Boretti is not going to shift to a lower part of the market. This is also not advisable since Boretti stands for a certain quality and has a name. The final pricing is depended on development costs, specific ceramic from a certain producer and the eventual UX which is then dependent on the chosen user group(s) to focus on.

Selling channels

Different selling channels are possible for this new product. At first can be thought of the most common way to sell induction cooktops at the moment which is (online) kitchen or electronics stores like Kookpunt or Coolblue. In the case the induction will completely integrated in and sold with a countertop, this is not an option. If Boretti is willing to use this channel, a standalone stove is needed or the design has to be similar to current built-in induction hobs and just have this kind of ceramic as the material on the top instead of the traditional glass. Since this would take away one of the strengths of the concept which is the way it can be totally integrated in the kitchen, this is not advisable. Other channels which would make more sense are kitchen retailers and new built house projects. Optimal usage of the integration and the new styling opportunities will be the case if using those channels. At last, Boretti could sell it themselves (online) which will mean large investments and not necessarily an improved selling experience.

Opportunities & limitations

To summarize, this new concept will shift the competitors for Boretti and also will need new ways of selling through other channels then Boretti is used to. This means new collaborations which will come with opportunities like integrating more of Boretti's kitchen appliances in a kitchen sold by a kitchen retailer for instance. Collaborations with parties like RAKceramics can mean other new innovations in the future as well. On the other hand those new (needed) collaborations might come with concessions having to be made by Boretti and not being in complete control of the busines strategy and final user experience anymore.

Figure 15: Current design of Hubstone

To get the specific needs, demands and wishes of the different possible target groups, combinations between lifestyles, house types and passion for cooking are made. Before making this, internal strategy presentations and price ranges were analyzed from Boretti (Boretti, 2019) to determine the correct target groups with sufficient income and matching the values of Boretti. The earlier kitchen and house research then helps making the total image of the different users. Multiple possible user groups are described below with their most important characteristics.

Freelancer - Shared living

Looking at one of the most uncommon living styles for now but one that will become bigger in the future is a freelancer that lives in a shared living building. Efficiency is of great importance here as well is the social part. See figure 16 for an impression.

- Marital status: Single
- Age: 25 - 30
- Work: Self employed Graphic designer
- Geographical: Travelling around the world in big cities in Japan, America and Western Europe
- Income: $39.000 a year
- Personal characteristics and values: Full of live, Exploring, Inviting, Forgiving, Flexible, Multitasking, Free
- Specific needs: Multifunctionality, flexibility and adaptability

Figure 16: Shared living environment

Passionate home chef - Maisonnete

One of the bigger possible user groups are passionate home chefs. Since buying hobs from Boretti is already an investment the users will most likely have some kind of passion for cooking. In this case we are looking at a young couple that lives together in a maisonnete and love to invite guests for whom the prepare a well thought trough high quality meal. See figure 17 for an impression.

- Marital status: Engaged
- Age: 25 - 35
- Work: Accountant
- Geographical: Living in a new built maisonette in Rotterdam
- Income: $42.000 a year
- Personal characteristics and values: Full of live, Exploring, Social, High end, Burgundy, Exuberant, “Levensgenieters” , Passion
- Specific needs: High quality cooking gear, inviting and luxury

Figure 17: Passionate home cook

Working from home - Studio
This person is comparable to the freelancer living in a co-living building only is she living alone in a studio. Still efficiency is of great importance but personality is added to this. See figure 18 for an impression.

- Marital status: Single
- Age: 25 - 35
- Work: Consultant
- Geographical: Living in a studio in Tokyo
- Income: $30.000 a year
- Personal characteristics and values: Less is more, Exploring, Inviting, Forgiving, Flexible, Multitasking, Simplistic
- Specific needs: Multifunctional and Personal


Figure 18: Living in a studio

Family - Detached house
A last important user group is families. Needing to cook for more people and in the case of the kids being older, using the kitchen with multiple people at the same time creates a need of sufficient cooking area and space. Next to that safety is of special importance here. See figure 19 for an impression.

- Marital status: Married
- Age: 30 - 55
- Work: Branch manager
- Geographical: Living in a new built maisonette in Rotterdam
- Income: $ 40.000 - $ 75.000 a year
- Personal characteristics and values: Inviting, Forgiving, Cozy, Famiglia, caring, social
- Specific needs: Inviting, Save & Cozy Further research


Figure 19: Family

It is advisable for Boretti to perform more research on the described groups if they intent to design for one or more of them since assumptions were made while creating the personas and unfortunately little user research was possible due to the COVID-19 virus.

The material that part of the product will be made off in this design case is a given. Where normally glass is used as the top layer of an induction hob, for this design a certain type of ceramic is used often referred to as “Gres-porcelain”. Boretti has multiple options open for different producers of the machines that make the ceramic plates and the producers of the ceramic plates themselves. Some of the properties, opportunities and limitations are the same for the different possible producers and some will defer. To get an image and know the boundaries and possibilities, research was done through conversations with people inside Boretti that are in contact with those companies and studying the websites and brochures of the different producers.

Possible producers

The producers can be divided in different parts of the process and industries. At first the machine industry that makes the machines to produce the ceramic plates including the companies System Ceramics and Sacmi. After that there is the ceramic industry which has the machines already and produces the ceramic plates themselves. Parties that Boretti are considering for this are Laminam, Inalco, Mazzari group, RAKceramics, Florim and Consentino. At last there are some companies like Kemie and Lineamarmi that uses those ceramic plates in their products.

General properties

Looking at the brochures from the different producers in general the material is resistance against heat and scratching and is easily cleanable. The actual way and amount of heat resistance differs slightly and will be discussed later. Those properties are validated with testing on prototypes that Boretti has at the moment. The finishing has to be matte at all times to be able to serve the purpose as intended. With possible slight differences the different sizes that can be produced have a thickness of 3mm, 6mm, 12mm, 14mm and 20mm. The maximum length is between 3000mm and 3200mm and the width has a maximum of 1200mm. In figure 20 an example of the looks the ceramic can have can be seen. The tiles of this kitchen are made at RAKceramics for this specific one but the looks of the different producers are comparable.

Difference heat tolerance

The most important issue of the ceramics is the heat tolerance. The induction system will heat up the pan which will then heat up the part of the ceramic that it touches. Due to thermic expansion the ceramic will expand locally which may result into cracking since the area around does not expand as well. This issue has to be solved either with the specific composition of the material, the way the induction system works or by not making the total countertop out of one piece but have cutouts for the cooking areas for instance. Depending on the chosen producer and therefore the composition of the specific ceramic, the product has to be designed differently. For the current products Boretti will make for this concept they are dependent on the possibilities of there producers. In the future, there is a great probability this issue can be solved with the material itself so the ideation will mostly exist of ideas in which the total countertop including the different cooking zones can be one piece of ceramic. Reason to believe that this will be possible in the near future is that RAKceramics already claims to have solved this issue. The question still remains whether this is solved in the material composition or with their induction system. A part of the ideation will cover different ways to solve the heat tolerance and cracking issues in the case it cannot be solved with the composition of the material itself.

Possibilities & limitations

The reason for choosing this material instead of the traditional glass for induction is the new possibilities and experience it offers. Most obvious is the new appearance possibilities. Multifunctionality and better use of space are things that follow. There is now the possibility to have the cooking zones as extra countertop space while not cooking and make it suitable for other functions. This will also make it easier for cleaning purposes. The limitations are mostly the earlier named finish and possible heat tolerance issues.

Figure 20: Impression of RAK ceramics

Next to trends and developments in the obvious areas that have to do with this project like housing, kitchens and cooking. Other trends that might not have directly to do with de product could also be of importance and generate new ideas to add value or take into account while developing the concept. To find those trends and developments de DEPEST method (Boeijen, 2014)) was used. The sources that are used range from observations to hard numbers on population from the Dutch institution CBS. More trends can be found in appendices B and G.

Demographical
The percentage of people living in apartments versus other house types is exponentially larger in Zuid-Holland and Noord-Holland then in the other provinces of the Netherlands at the moment (CBS, 2015). Houses in bigger cities are becoming both smaller and more expensive.

Political/Ecological
Already mentioned in the context chapter is that cooking on gas is disappearing due to regulations in the Netherlands (Rijksoverheid). This ban is also upcoming in cities in America for instance where people have to switch from gas to electric powered hobs. (NPR, 2019)

Technologies
Multiple technologies are upcoming that might be useful to integrate or make use of in the final design of this project. Starting with one of the most bespoken trends which is IOT. With IOT everything can be connected to each other and controlled and managed through different devices. Also a lot of data can and is being collected with products that make use of these technologies. A reason why this trend can be relevant is at first the way the induction hob can be controlled for which the use of smart devices can be an option to consider. Next to that collecting data from usage might help developing the product better or make it self-learning to play more into the specific way of usage of the customer.

Another thing that can be seen back in some products is interactive projection. An example for this is a projected keyboard for computers. This technology might as well be useful for the final user experience.

Wireless charging of devices is becoming the next standard for mobile devices like smartphones and tablets. Some laptops already make use of this technology as well. Since this wireless charging works with induction, there might be the opportunity to add this function to an induction hob.

Something that is rising in popularity are air purifiers. One of the most well-known brands is Dyson. Those air purifiers clean the air from things like pollen to prevent allergic reactions and make the air more healthy to breath in overall. Since there is already a development that extractor hoods are becoming recircular and thus have to be able to blow the air back into the house cleaned, there might be an opportunity to combine this with being an air purifier. Some parts are already overlapping like certain types of filters and making use of plasma technologies. A big difference is the use of HEPA filters in air purifiers and the way plasma technology is used.

Furthermore, newer smart devices and laptops make use of finger print recognition and face recognition as a security principle. This could be used as a safety function to provide kids using the hob while not being watched by their parents for instance.

Opportunities & limitations
Since there will be more smaller but expensive houses in the future, this will mean an interesting target group. This group will need space efficiency but can afford high end products. The fact that cooking on gas is disappearing is positive for this concept being developed as well. The different named technologies could all add value to the product in different ways. Possible limitations for this are the patents other companies have for certain of these technologies.

When looking at the different discussed subjects in the context and analysis sections, some themes keep coming back and result in important takeaways to consider implementing in the end design or can be used as search areas for the ideation phase.

Strategy
This new product will have to come with some kind of a new strategy in terms of cooperation, marketing and selling. New production methods are needed, working together with other companies creating a similar concept might lead to quicker innovations and other selling channels will be needed as a result of the total integration in the countertop and selling it as a whole. Those new selling channels might be an opportunity for Boretti to have an unique position of having their product(s) already integrated in kitchens or countertops that are sold which can result in people buying their other kitchen appliances from Boretti as well.

Multipurpose
For many different reasons and in different ways one thing that keeps coming forward is the need for multifunction. Depending on the user and situation the different uses or functions will vary. For instance someone living in a co-living space or someone working from home would benefit if the product while not being cooked on can be a place to work at. For the passionate cook the surface would come in handy as extra cutting space or to make a dough on while not being cooked on. The space or product adapting to the needs at a certain moment of the user is fitting the time we are living in and should be implemented in the concept.

Integration
One of the main driving forces originally for this concept is the level of integration it provides. The induction can be totally integrated and even invisible in the countertop depending on the collaboration with a certain producer. Since this is one of the main strengths is should be done properly. Given the fact that Boretti will now be in control of the whole countertop, this gives the opportunity to integrate even more Boretti appliances. Looking at trends and competitors, things like teppanyaki plates and “Chef Sign” like appliances should be considered. This is the change to make the ultimate functioning worktop for a passionate home chef.

Freedom
Looking at competitors, often it is offered to combine certain elements to create your own induction hob. Combining a flex zone with two cooking zones a grill and a Teppanyaki plate for instance. Since the electronics will be underneath the countertop this could be an easy integrateable option for this concept as well in the case the user interface is flexible. This gives the opportunity to create a personal countertop especially combined with the fact the material can be chosen as well contradicting to traditional (induction) hobs. To be able to integrate a Teppanyaki plate, either a cutout should be made or it could just be a standalone accessory which can be used on a flex zone of the induction system for instance.

Ventilation
Ventilation is becoming more important in new built projects and the new standard will be recircular air extractors. This is something Boretti should play in to and combined with the trend of having air purifiers in your house a hybrid could be designed between an air extractor and an air purifier adding to the feeling of the kitchen connecting to the living space and not only being for cooking anymore.

Wireless charging
An upcoming technology using induction as well is wireless charging. With changes in the software or probable small changes on electronics this might be easily implementable. Varying on the user this should just be to charge your phone or tablet while cooking or can actually help making the top serve as a place to work at while charging your laptop.

IOT
One undeniable development is IOT. These technologies are implemented in more and more kinds of products. The way it could and perhaps should be integrated in this concept, depending on the user group, is to be able to control the hob with smart devices. Next to that it can be used to collect data and improve the product while being used or make it self-learning.

To create a design fitting the targeted user groups , taking into account the current developments and suit Boretti as a company, a list of requirements is created with the main drivers being the most important ones.

As a result of the findings and conclusions of the context and analysis sections, those main drivers were created. A full list of requirements can be found in Appendix H. The main drivers are as following:

THE PRODUCT SHOULD ENTER THE MARKET IN 2021/2022 The design choices being made should consider the developments and trends moving towards 2020/2021 and be feasible to be produced by then.

NEXT TO COOKING WITH PANS ON TOP, THE SURFACE SHOULD SURVE OTHER PURPOSES DEPENDING ON THE NEEDS OF THE SPECIFIC USER GROUP One of the most important added values of using the new material is the possibility to provide multifunctionality of the cooking surface. The final design should make optimal use of this.

THE INDUCTION COOKING HAS TO BE SUITABLE FOR ALL TYPES OF COOKING IN PANS Since Boretti is about passion for cooking, there should be no restrictions with cooking on the induction. The surface must not crack with all kinds of cooking like pan frying for instance.

THE DESIGN HAS TO PROVIDE THE POSSIBILITY TO INTEGRATE AN AIR PURIFIER To increase the connection between cooking and living and considering the trend of air purifiers, this should be able to be combined with the air extractor already needed.

This section is about diverging and creating many (partial) solutions within the scope of the project. Ranging from the functions of the worktop to the way cooking zones are indicated.

Following the analysis and main drivers an ideation phase was performed. To get to the right ideas, the “problem” was split up in partial subjects that needed to be tackled or ideated on.

At first the unique opportunities provided by having the induction totally integrated in the countertop were explored in combination with the different needs of user groups in terms of multifunctionality and adaptability.

Suiting the different kinds of possible users, this multifunctionality can be in terms of combining cooking and living, expanding the possibilities of cooking or making the looks as clean as possible.

Second, the user interface was ideated on. Questions like how can the user control the cooking zones and how should those cooking zone locations be indicated were the leading thread for this.

Another topic was the way an air extractor should be combined with the cooking top. Should it be integrated in the countertop itself or be standalone? How can it be combined with the functions of an air purifier to improve the experience of combining living and cooking?

To get to different ideas, at first a scenario with some functions proved interesting in the analysis section was made and can be seen in figure 21. Next, different brainstorm sessions were performed and inspiration from other products was used.

Figure 21: First idea of an user scenario

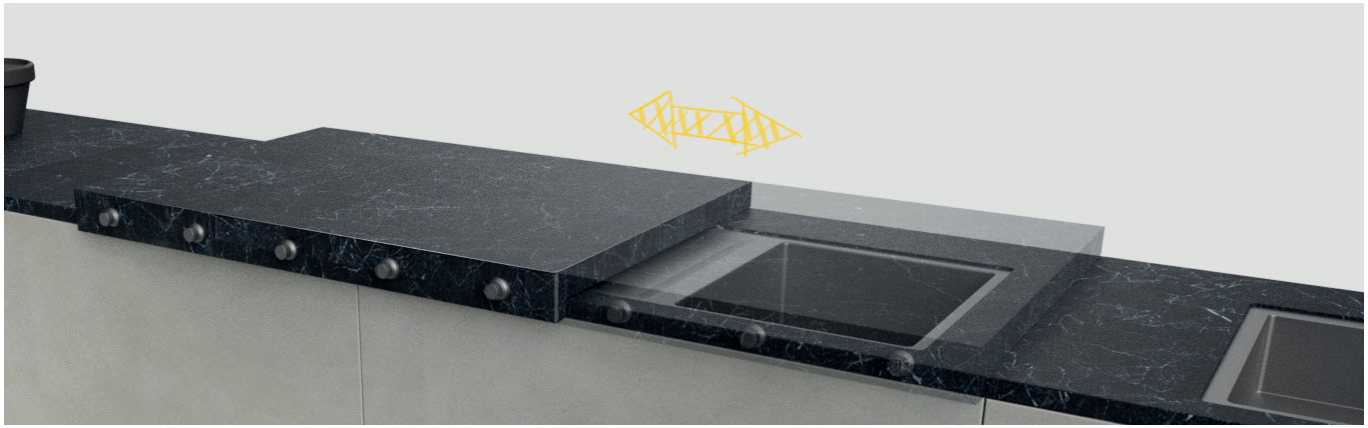


Figure 22: Movable induction block

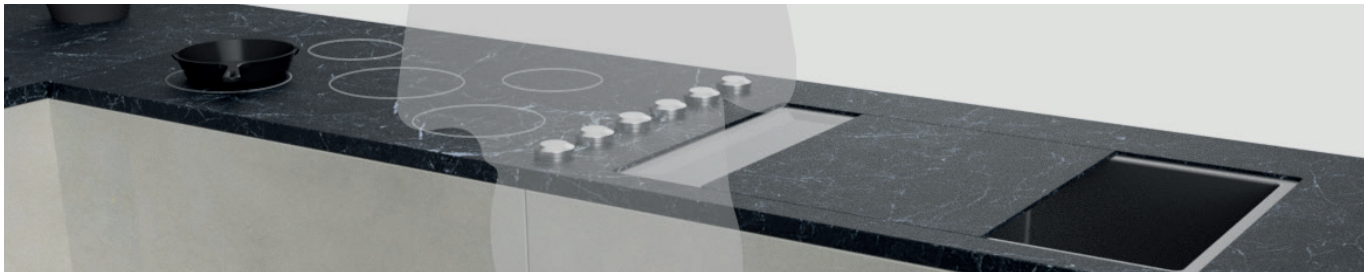


Figure 23: Cover plates and cutting boards in one

Figure 24: Example of current sous vide solution

Integrating other cooking functions

To create ideas on the integration of other cooking functions in the worktop next to the induction itself, examples from the analysis on kitchens were used to select different functions. To improve the experience of a home chef, integrations like a teppanyaki plate to grill on or induction stewing facilities are on the market. Also making it possible to cook sous vide or deep frying in a pan, both on a constant temperature which can be of added value for a passionate home cook. In figures 22 and 23 examples can be seen on how to integrate the teppanyaki plate and induction stewing. The first solution is making a moveable block with the induction zones in it which can cover the integrated appliances and only show them when needed. The second one uses covers which also double as cutting boards. In figure 24 a current solution on sous vide cooking can be seen. In the ideal situation this will not be needed anymore by creating a solution with the induction itself. Other less technical ideas to integrate other functions in the countertop are solutions like an integrated knife block. The ideation on functionality can be found in appendix I.

Figure 25: Charging smart device with induction

Figure 26: Shared living multipurpose furniture solution

Integrating functions for living

One of the original reasons for the Carrara project was to have more connection between kitchen and living room. Next to that, the analysis section pointed out the urge for multifunctionality and the space/product adapting to your needs is growing. For this reason, ideation was performed on integrating functions for living to enhance this experience. Important findings of this ideation are ideas like integrating induction for charging smart device or laptop. An example can be seen in figure 25. In this idea it in assumed that the same induction used for cooking can also be used for charging after consulting an electronics expert (see appendix J). This could also be done on bigger scale like in a shared living environment for instance. A large table could serve both the functions of cooking and working depending on the needs at a specific moment. See figure 26 for an example. Other functions like ambient light or something that keeps your coffee warm while working are also considered. At last an air purifier could be integrated which will be explored more later on.

Figure 27: Touch screen

Figure 28: Control by mechanical knobs on top

Figure 29: Control by mechanical knobs on the front

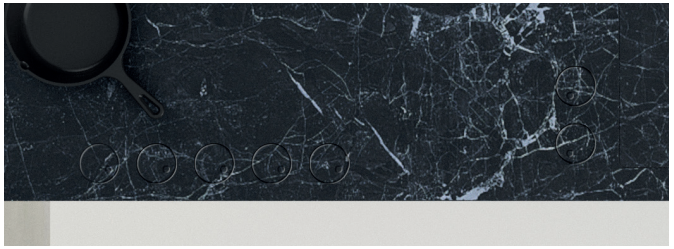


Figure 30: Control mechanical knobs inlay

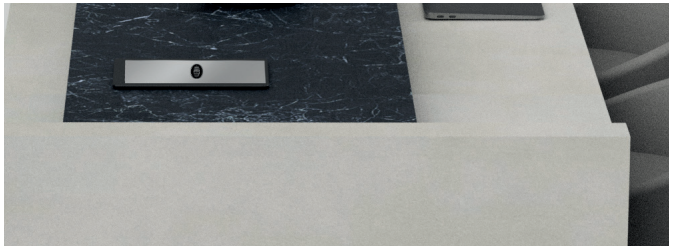


Figure 31: Control by smart device

Figure 32: Control by smart knob (no fixed location controlling al zones with one knob)

Controlling the cooking zones

To ideate on the control of the cooking zones, current control methods were explored (see appendix K) and complemented with new possibilities. The main methods/directions to choose from can be seen in figure 27 to 32. Figure 27 shows the typical solution of induction hobs which is using a touch/tap screen. Figures 28 until 30 show mechanical knobs implemented in different ways. Figure 31 shows the option to control the cooking zones with an app on your tablet or smartphone. At last, a smart knob which can move around and can control all different cooking zones can be seen in figure 32.

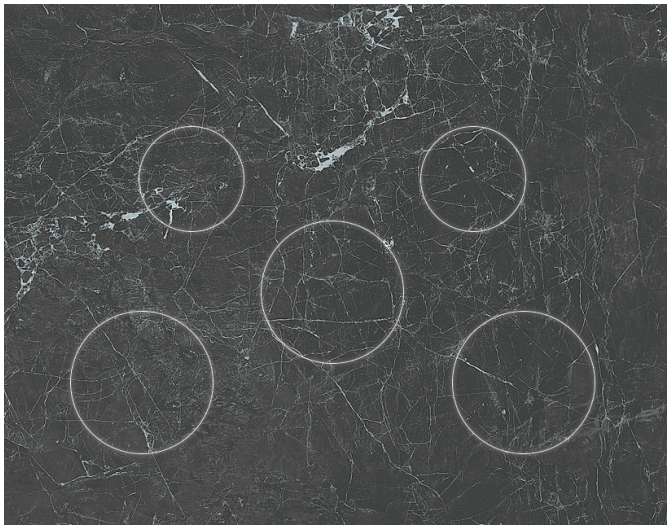


Figure 33: Showing the cooking zones with light projection

Figure 34: Showing the cooking zones with a print

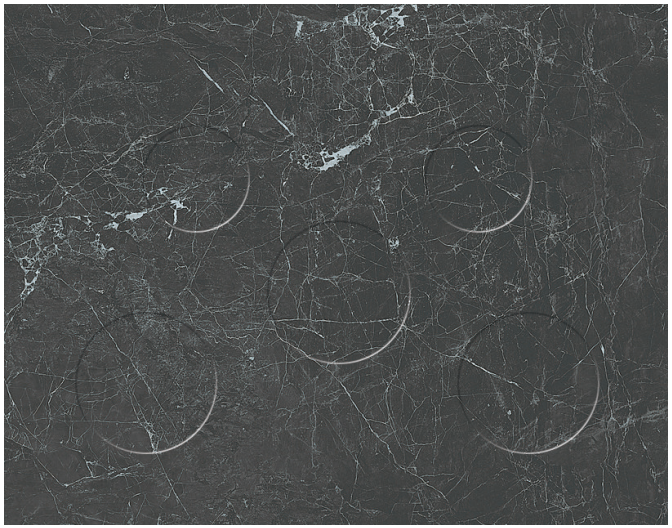


Figure 35: Showing the cooking zones with an inlay

Cooking zone indications

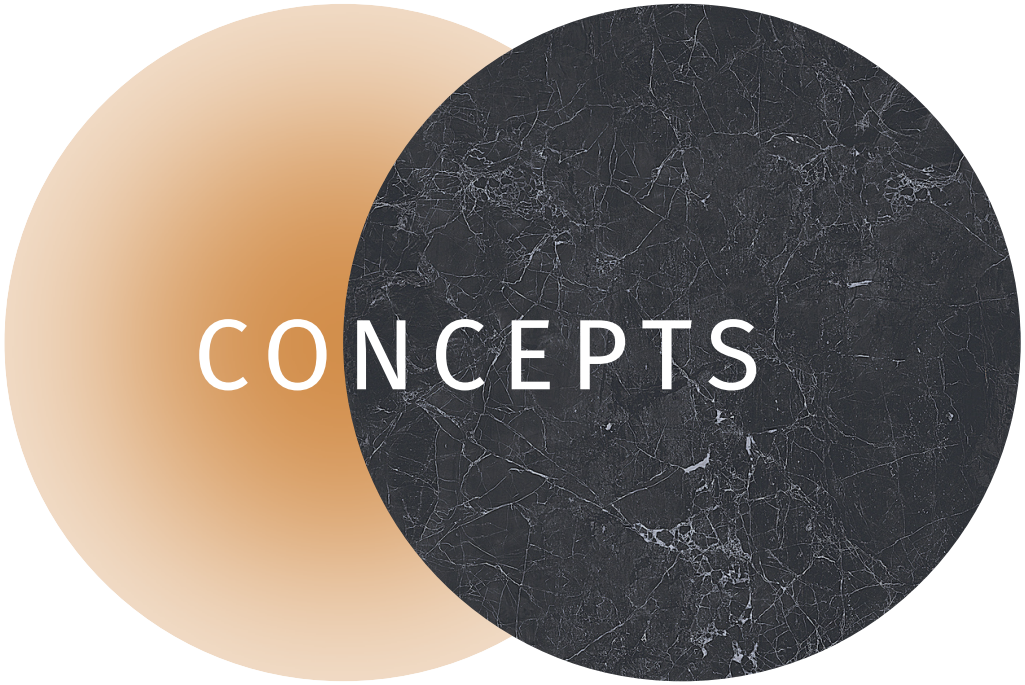
To indicate the locations of the cooking zones, different solutions can be used. The main methods found and ideated on are using a print, using projection or using a physical way like an inlay or carved out circle. From each method an example can be seen in figures 33 to 35, more variations can be found in appendix L. Ideation on how the cooking zone module is placed can be seen in appendix M.

Figure 36: Control by mechanical knobs on the front

Figure 37: Control by mechanical knobs on the front

Air extraction

Cooking brings fumes and smells with it which have to be taken away by an air extractor. Roughly they can be split up into stand-alone extractor hoods and countertop integrated air extractors. Another division is recirculation hoods and one that makes use of an exhaust ventilation system. The first one keeps the air in the house and cleans it, the second one guides the air to outside the house. As concluded in the analysis section, recirculation hoods will be the new standard. For this reason, all variations created during the ideation make use of recirculation. Next to that, the idea was created to make the air extractor function as an air purifier as well, since this is one of the trends found in the analysis section and it attributes to a connection between kitchen and living room. Appendix N shows a comparison between air extractors and air purifiers. For both integrated air extractors and standalone extractor hoods ideas were generated. From both an example can be seen above in figures 36 and 37. For more ideas, see appendix O.



Different combinations of partial solutions were made to create different concepts and form total solutions fulfilling the main drivers and suiting a specific target group.

Figure 38: Overview of the Flessibile concept

Flessibile is not only about cooking anymore, it combines the needs of a living space and a kitchen. It makes ultimate use of the fact that the ceramic surface can be used for other purposes when not cooking on it. The induction is also used for charging smart devices and laptops to be able to use as a work space for people that work at home. The part of the countertop that contains the induction is movable to make it even more adaptive to the specific needs of the user at that moment. This also makes it possible to change your orientation when cooking. Above, in figure 38 an impression can be seen. On the right an explanatory top view can be seen in figure 39. The most suitable control method will be either a smart device or the smart knob. Since the induction is movable a fixed location for the control like mechanical knobs or a touch screen makes no sense. Figures 40 and 41 show those solutions. Both an integrated air extractor in the countertop or an extractor hood can be sufficient for this concept. (see figure 42 and 43). The addition of mood lighting coming from the air extraction can add value to the concept. The induction zones are best to show with either light projection or a subtle print as can be seen in figures 44 and 45. For this concept, four cooking zones are integrated.

Figure 39: Top view with movement induction block

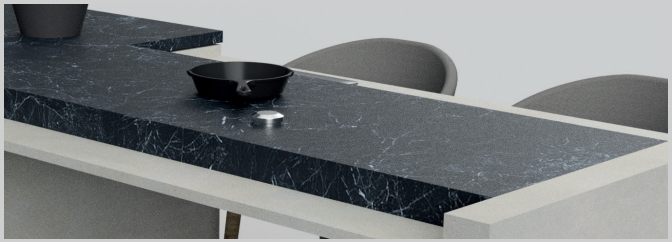


Figure 40: Control with smart knob

Figure 41: Control with smart device

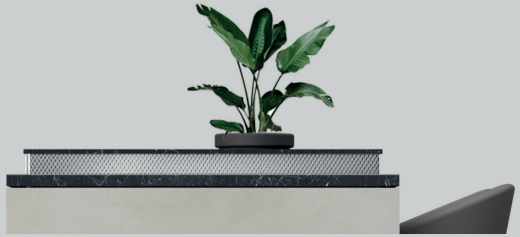


Figure 42: Integrated air extractor

Figure 43: Stand alone extractor hood

Figure 44: Showing the zones with a print

Figure 45: Showing the zones with projection

Figure 46: Impression of the Semplicistico concept

Semplicistico makes ultimate use of the cooking interface being able to disappear when you are done with it. This concept is suited for people that care more about design and simplicity then cooking. Impressions can be seen in figures 46 and 47. It might even be for people that do not cook often and order takeaway for instance. For them there is no need to have a hob of any type present at all times and it should just appear when needed. For this reason a smart knob or a smart device would be the best option to control the zones (see figures 48 and 49). The zones could either have a simple printed indication or nothing at all (figures 50 and 51). In the last case the interface will show when the pan is on the correct location. Semplicistico will have two cooking zones. A clear visible air extractor would not fit this concept, for that reason it would be best to work it away into furniture like for example is done in figure 52.

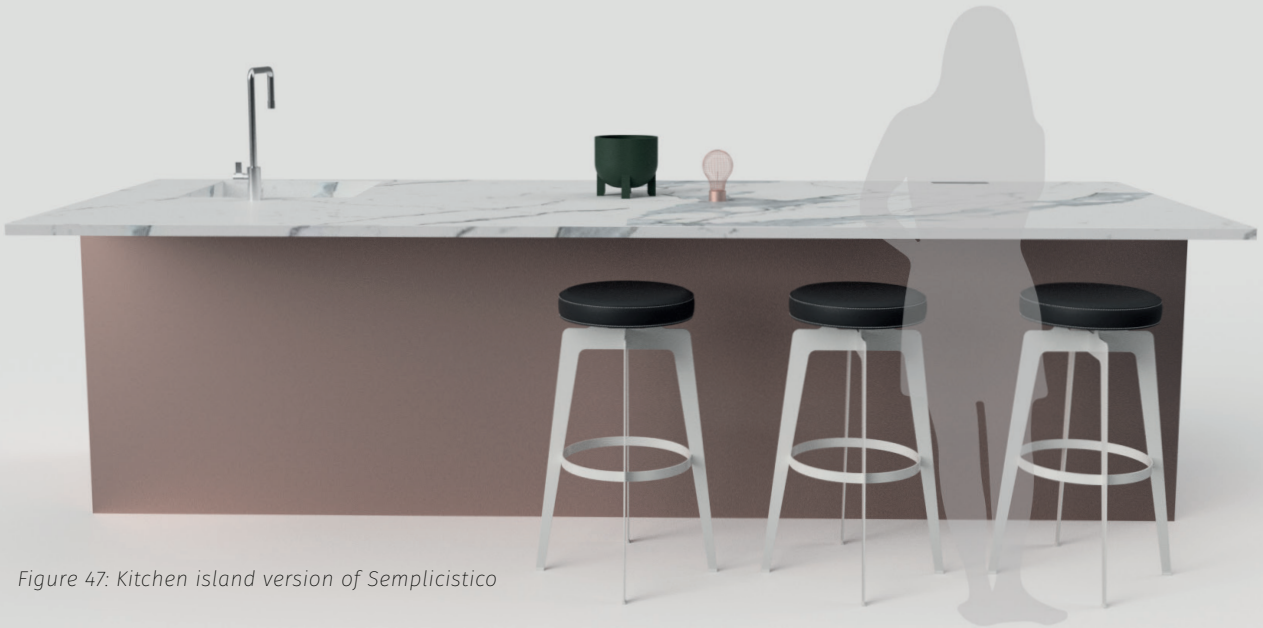


Figure 47: Kitchen island version of Semplicistico

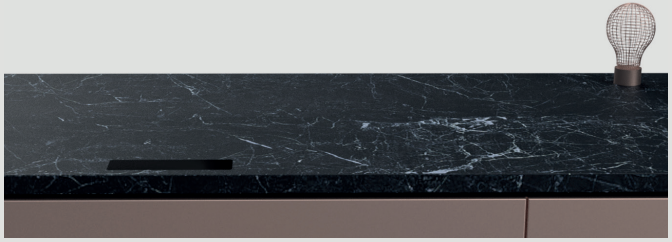


Figure 48: Touch screen control Semplecisitco

Figure 49: Smart knob control Semplecisitco

Figure 50: Subtile print cooking zones

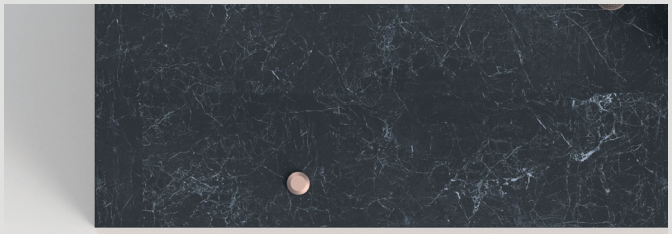


Figure 51: No indication of cooking zones at all

Figure 52: Furniture air extractor solution

Appassionato is all about creating the ultimate worktop for the passionate home chef. Everything one might need is included to cook the best meals. Next to four or five induction zones, applications like a teppanyaki grill and more can be integrated. See figure 53 for an impression. This can be done either covered by the induction hob itself or cover plates which double as cutting boards (see figures 60 and 61). Other additions like an integrated knife block are easy to implement if desired. To control the zones, mechanical knobs either on the front or on top are suggested see figure 54 and 55). This gives more control on the intensity of the cooking zones and is closer to the experience with a gas hob which a lot of home chefs can appreciate. Air extraction can either be done by a traditional hood or an integrated air extractor (figures 56 and 57). In this case the cooking zones can be more visible in the form of a contrasting print or carved out rings (figures 58 and 59).

Figure 53: Impression Appassionato

Figure 54: Control by knobs on the front

Figure 55: Control by inlay knobs

Figure 56: Traditional extractor hood solution

Figure 57: Integrated air extractor

Figure 58: Show zones with print

Figure 59: Show zones with carved out rings

Figure 60: Cover plate solution

Figure 61: Moving induction block solution

Before proceeding to the embodiment phase, one of the concepts had to be chosen to work out in detail. To make this choice, a Harris profile was used as well as a discussion with the product manager of Boretti and their designer.

To get better insight on the differences and direction of each concept, a division was made between no passion for cooking and much passion for cooking as well as a division between small innovations and much innovation which were all put on axis to divide the concepts and partial solutions as can be seen in figure 63. As can be seen, both Appassionato and Flessibile end up high on the innovation axis were Semplecistico ends lower. Looking at passion for cooking, Appasionatio ends high were both Flessibile and Semplecistico end lower.

For the Harris profile, the main drivers were used to test each concept on with an addition of parts of the assignment and values of Boretti. Those added criteria are;
- The attribution to a connection between living and kitchen, which is part of the original assignment.
- Passione Cucina (passion for cooking), which is the core value of Boretti.
- Amount of innovation, being innovative is one of the leading values which resulted in this project.

As can be seen in figure 62, both Flessibile and Appassionato score high. Flessibile scores higher on connecting the living with the kitchen and innovation where Appassionatio scores higher on Passione Cucina. In discussion with Boretti therefore a combination of the two is chosen to have both the connection with the living room while still making it very suitable for the passionate home cook which is fitting the current customer profile of Boretti.

Concept

Criteria	Flessibile	Semplicistico	Appassionato
Enter the market in 2021/2022	+	-	++
Multifunctionallity of the surface	++	+	++
All kinds of cooking in pans	+	+	+
Integration of an air purifier	++	-	++
Connection between living and kitchen	++	+	-
Passione Cucina	+	-	++
Innovation	++	-	+

Figure 62: Filled in Harris profile

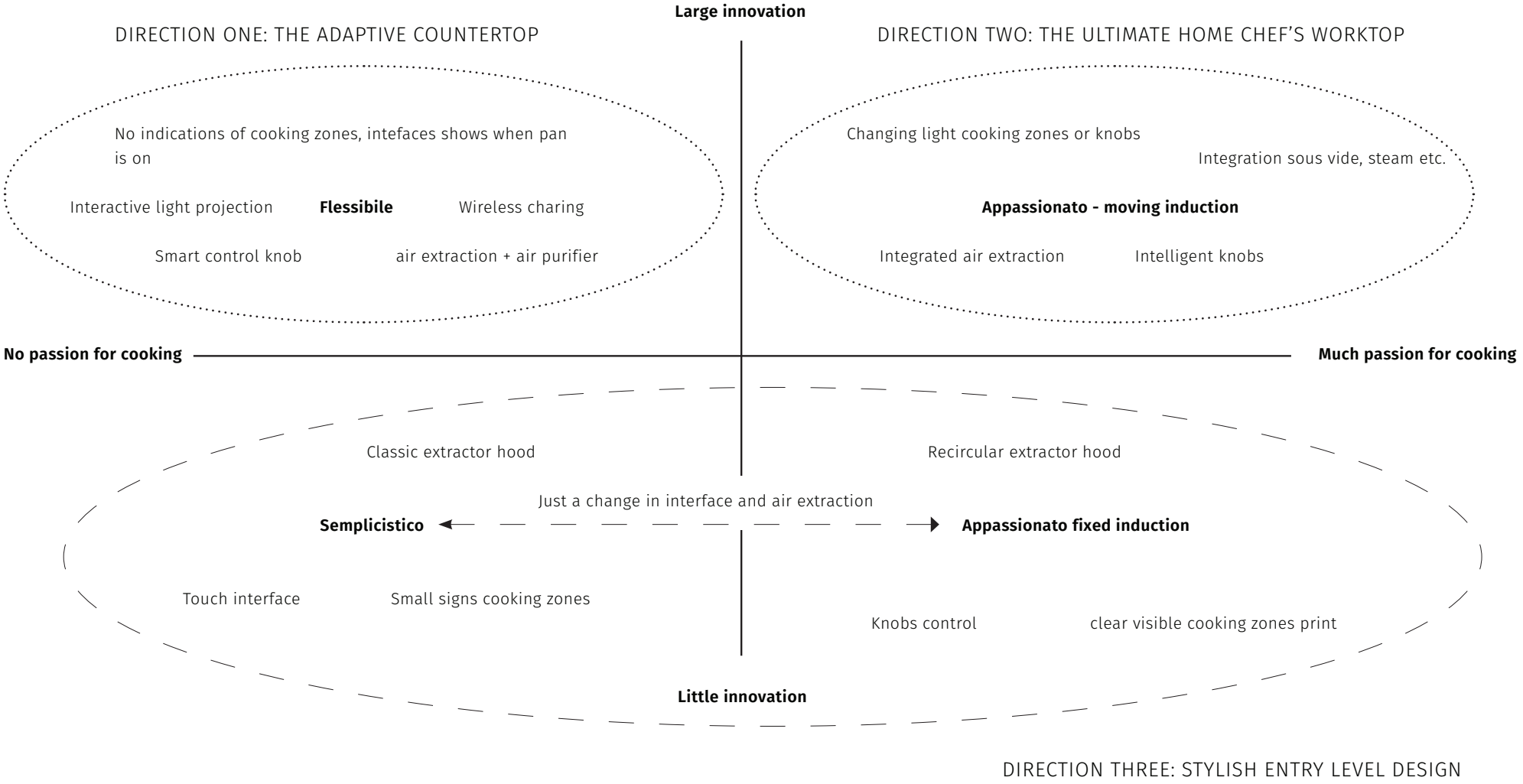


Figure 63: Devision of ideas on axis

Figure 64: New concept

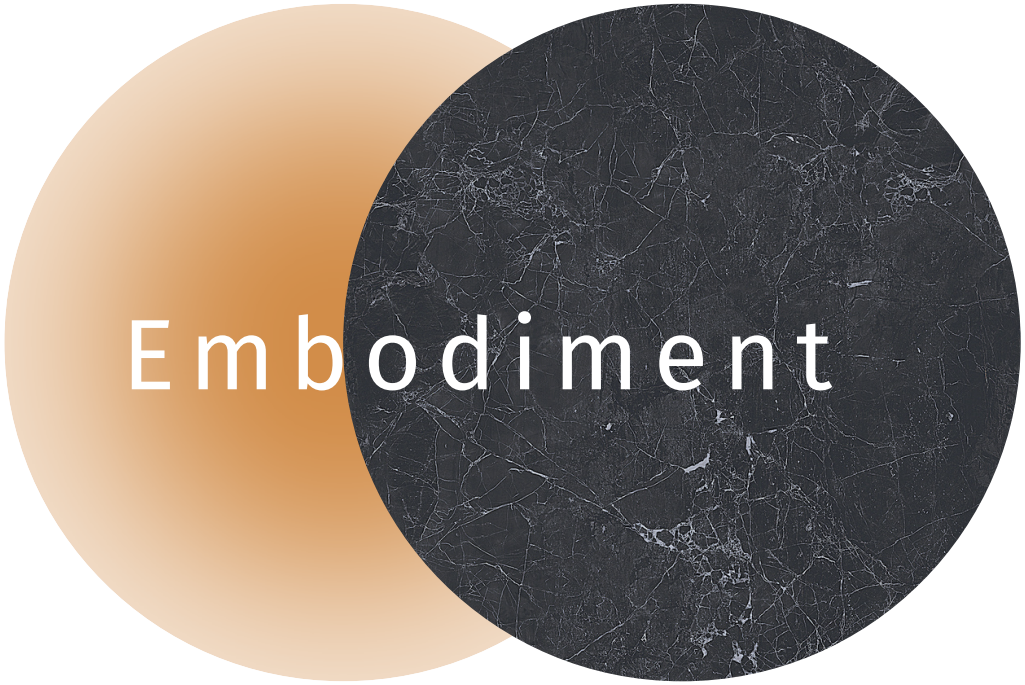
To make the ultimate combination of the concepts, features from both are implemented. From Flessibile, the integration of charging spots for (smart) devices is implemented. From Appassionato, the option to integrate different other kitchen appliances is implemented. To create more options for both living and cooking purposes, an accessory bar can be integrated in which different add-ons can be installed. This can range from a Boretti water tap to holders for spatulas or things like pens. In the case of a kitchen island, the countertop can be split up in a side suited for cooking and one for living.

To control the cooking zones, the smart knob solution is chosen. This offers more flexibility since it can be put away but still has the filling of mechanical knobs since the intensity of the cooking zones are controlled by rotation of the knob.

Since the side of the countertop were the cooking zones are located is dedicated for cooking, the indications of the locations can be permanent but are still desired to be subtle.

The accessory bar in the middle can also be used to place a downdraft air extractor which can double as an air purifier and had lighting for cooking and for atmosphere integrated in it.

The iterations of combining both concepts that leaded to the concept as can be seen on the left in figure 64, see appendix P.



To make the concept work as intended, further development is needed. The looks have to be worked out, the user interaction, all the components needed and finally the product architecture and materials and production.

After choosing one of the concepts, the main drivers and list of requirements (see full list in appendix Q) were slightly adjusted. For the next phase they are as following:

THE PRODUCT SHOULD ENTER THE MARKET IN 2021/2022 This driver remains the same.

WHEN NOT COOKING ON THE INDUCTION, THE SURFACE ABOVE CAN BE USED FOR OTHER COOKING PURPOSES This driver is slightly adjusted since this part is specifically dedicated to cooking.

THE INDUCTION COOKING HAS TO BE SUITABLE FOR ALL TYPES OF COOKING IN PANS This driver remains the same.

THE DESIGN HAS TO PROVIDE THE POSSIBILITY TO INTEGRATE AN AIR PURIFIER This driver remains the same.

THE DESIGN OFFERS THE POSSIBILITY TO INTEGRATE APPLIANCES AND ACCESSORIES FOR BOTH LIVING AND COOKING This driver is added since this is one of the core features of the chosen combined concept.

Something that will be a leading thread for the further development of the product design as well is to have references in the product to cooking on gas. Many home cooks mis the feeling one has when cooking on a gas hob. This is something that was pointed out one the GLUE event as well by people that were passionate about cooking. See appendix R for the conclusions of being on the GLUE event were a prototype was standing of the concept of Boretti which is shown in the assignment section of this report. Also, the gas stoves of Boretti is were people know them from which makes is of extra added value to have such a reference.

Since the concept consist of many different parts, like the induction zones themselves, the countertop, the accessory bar and the air extraction, It is not feasible to develop everything to be production ready with the given time. For this reason in discussion with Nico Admiraal, being the Product manager of Boretti at that time, and Jacco Bregonje, being the designer of many Boretti appliances and the Carrara project, a scope was agreed on of what things will be further development of the concept.

The scope that was agreed on is as following; The total layout of an example kitchen with everything integrated has to be given with the product architecture partially worked out to make it believable.

The thing that will have the focus in the next phase is the smart knob. This, because the smart knob is the thing the user will see and interact with. Next to that, the product architecture of both the induction zones and the air extractor will mostly depend on the producer of those things that Boretti is going to work with. The smart knob is new, and will be one of the main features Boretti will distinguish themselves with when competitors will enter the market with a similar concept of having this kind of ceramic on top of induction zones.

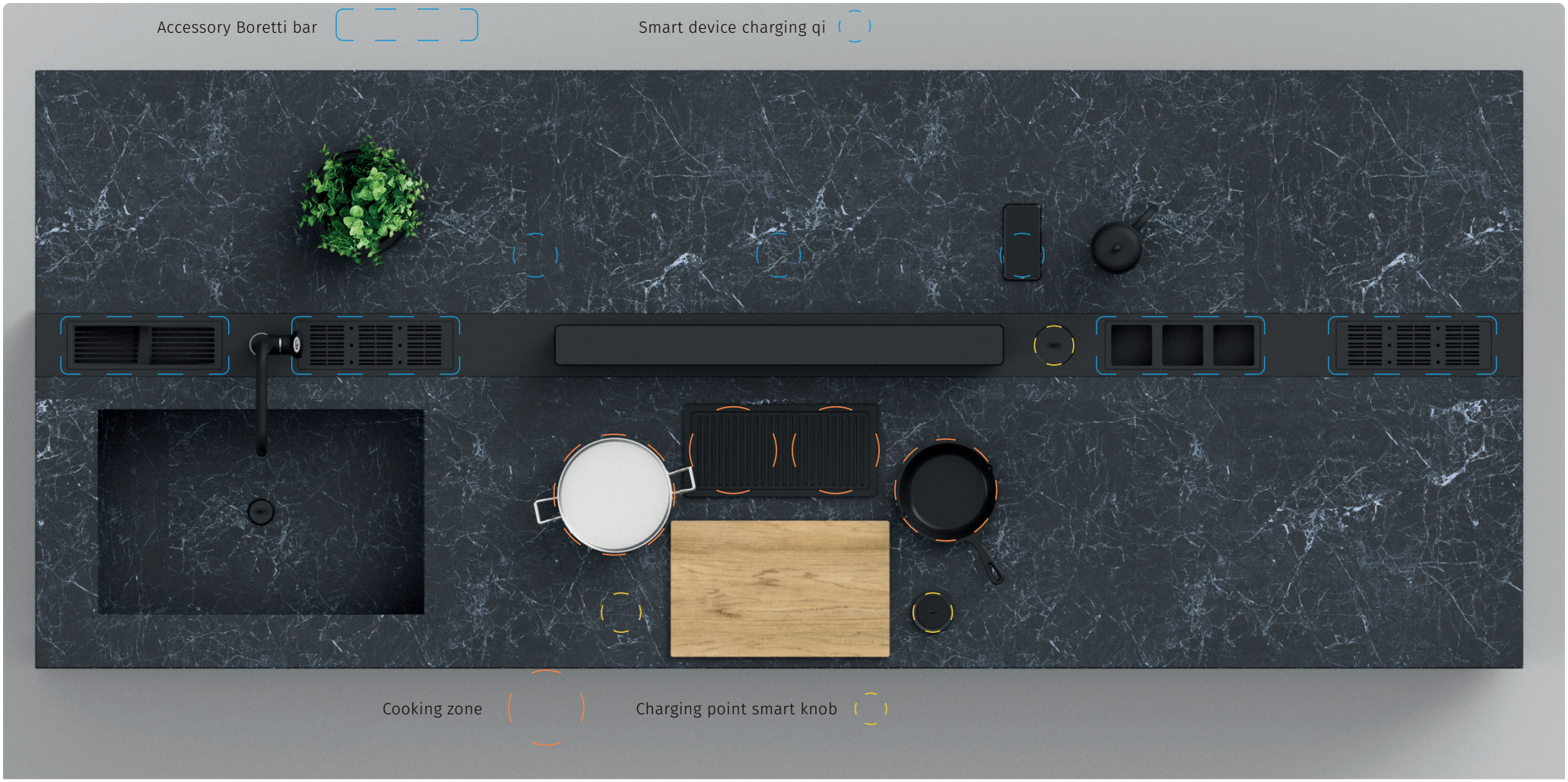


Figure 65: Countertop layout kitchen island

Figure 66: Example countertop layout kitchen block

Figure 67: Charging location in drawer.

The final product must be suited for both kitchen island and classic kitchen blocks solutions. On the left in figures 65 and 66 an example layout is given for respectively a kitchen island and a kitchen block. In both examples the accessory bar and four cooking zones are integrated. However, the accessory bar is not mandatory to include for the costumers. Furthermore, it is possible to have an other amount of cooking zones as well. The version that is worked out in detail has four cooking zones, an accessory bar, a downdraft air extractor/air purifier and wireless charging spots integrated.

Cooking zones

The locations of the cooking zones are not distributed in the classic layout of hobs where they are in a square. They are located near the back of the countertop and are placed in a way the user can work from the center with a cutting board and the control unit. This way, the costumer can have an overview of the pans and everything that is happening while staying in the center instead of having to cut somewhere next to the zones like with a traditional hob. Different layouts of the location of the cooking zones were tested and evaluated with a few test persons (see appendix R). More elaboration on the selection of other amounts of cooking zones, flex zones and more can be found in the section product placement.

Charging and storage smart knob

When not using the smart knob, it has to be stored and simultaneously charged. When the costumer also implemented the accessory bar like in the version that is worked out in this project, it can be placed on a dedicated location for the knob next to the air extractor. If this is not the case, a charging and storage spot can be integrated in a drawer directly underneath the induction zones of which an example can be seen in figure 67. The bottom shape of the smart knob will fit the debossed circle in either the accessory bar or the drawer. The charging spot is also were the branding of Boretti will be just as on the smart knob itself.

Qi charging spots

On the living side of the countertop, Qi charging spots can be integrated to charge your smart device or laptop. On the cooking side, Qi charging spots are integrated to give power to your smart knob so it can never turn of during use.

Accessory bar

The total size of the accessory bar has to be customizable, since not everyone will buy a same size kitchen. Since the total size of the kitchen block will depend on multiple standard cabinet sizes presumably, there can be a selection of standard size accessory bars as well. The accessory bar will have same sized slots in which different accessories of Boretti can be placed. There is also room for appliances like a water tap and logically the downdraft air extractor.

Downdraft air extractor

When including the accessory bar, this is the ultimate location for the downdraft air extractor. In this way it does not have to break up the surface of the countertop.

Figure 68: Example looks ceramic slabs from Laminam

The looks of the total kitchen and countertop will depend a lot on the choices of Boretti whom to work with in terms of producers of the ceramic slab as well as the choices the customer will make.

Countertop

The countertop itself will have endless possibilities depending on the catalogue of the producer. The customer will therefore be free to choose and personalize this part of the total design. Three examples from Laminam which is used in the current Carrara concept can be seen on the left in figure 68. Just like the material look of the countertop, the size is up to the costumer. Only the thickness will be dependent on the producer Boretti choses to work with.

Cooking zone indications

Like explained before, the way the cooking zones will be indicated is with a print. This can still be done in different ways which. It is advisable for Boretti to offer a selection of prints available. Three examples can be seen on the right in figure 69. The upper one uses a dotted circle. The middle one uses a similar appearance to the rest of the slab but breaks up the lines of the marble for example. The last one uses a simple print which can be the same color as the rest of the slab only more reflective as can be seen in the next subchapter. More variations and pros and cons can be found in appendix S.

Wireless charging spot locations

The wireless charging spot locations for both the smart devices and the knob, will be indicated in a similar way as the cooking zones. The indication does not have to be as big as the knob or phone like the cooking zone indications are as big as the zones themselves. The smart devices will give feedback when it is charging after which one knows it is on the right place. The knob will snap to the exact space with magnets.

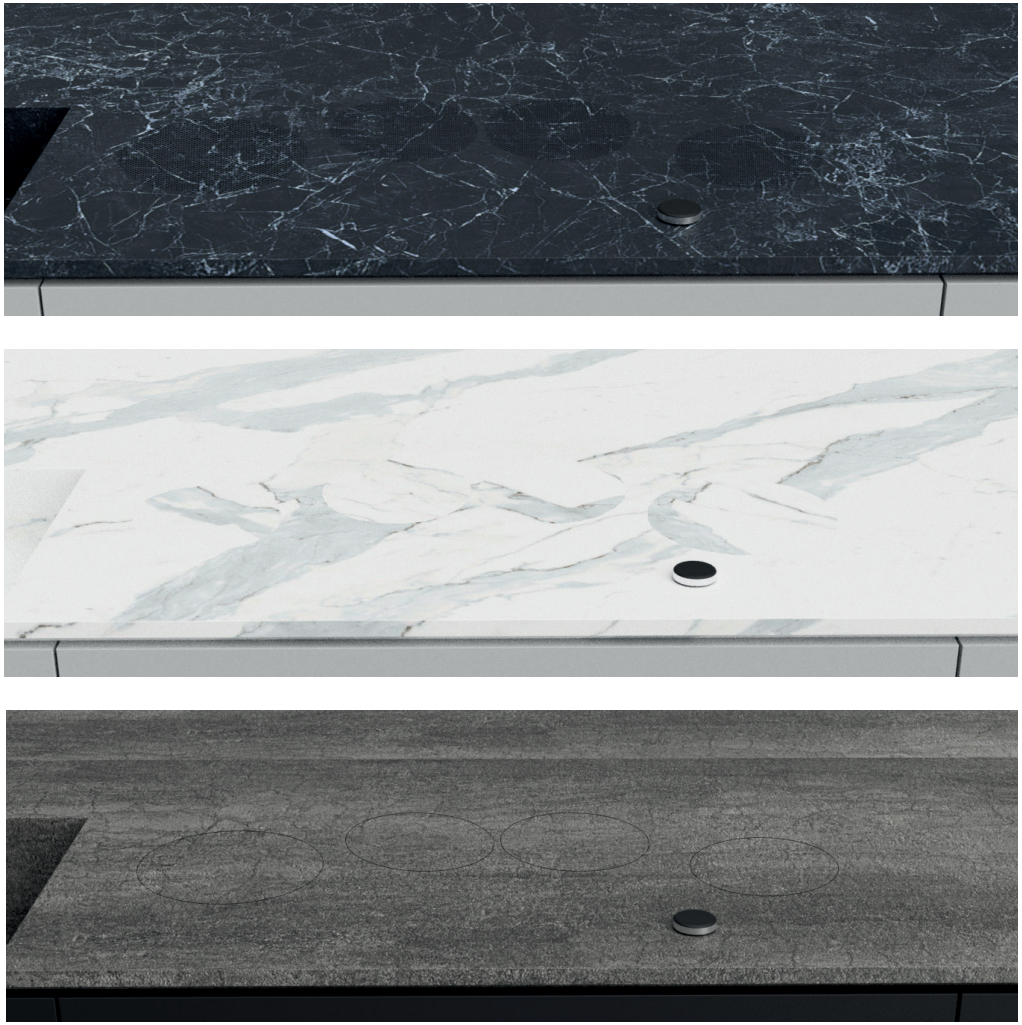


Figure 69: Cooking zone indications

Figure 70: Looks of the accessory bar

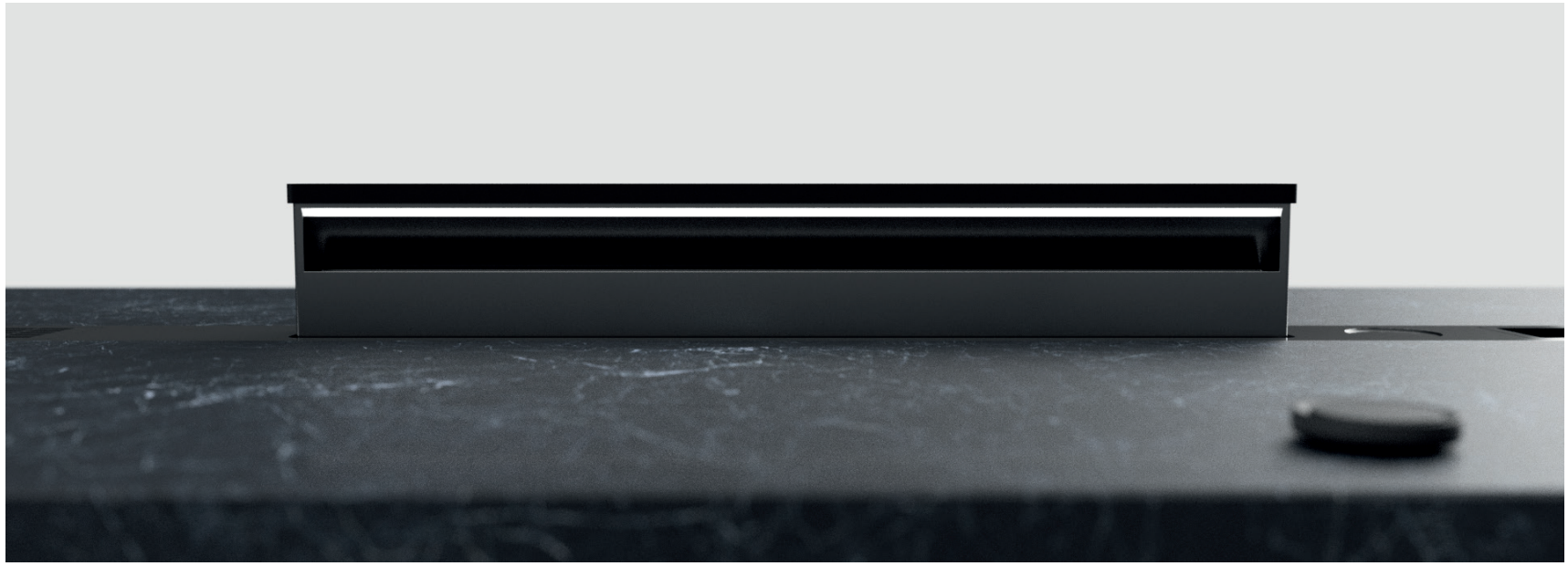


Figure 71: Looks of the air extractor

Accessory bar

The design of the accessory bar is simplistic, it has to divide the total countertop into two pieces and serve for multiple functions but the kitchen still has to look clean. The material look for now is the same color as parts of the knob. In the end, this will be something people have a choice in as well. Presumably, both the knob and the accessory bar will have a few options to choose from in a mix and match kind of style. An example of the looks of the accessory bar can be seen in figure 70,

Air extractor

The looks of the air extractor are mainly based on function at the moment. It must disappear when not being used and furthermore fit the design of the accessory bar and the smart knob.
An example of the looks of the air extractor can be seen in figure 71.

Figure 72: Smart knob material variations

Smart knob

Since the smart knob had the main focus for the embodiment, the looks have been iterated most on. Before designing the knob, reference products were looked up, see appendix T for an inspirational board that helped defining the shape. The total design process of the knob can be seen in appendix U. The shape has to do with both function and looks. The rotational part has ribs for having more grip. Since it rotates, a rotational symmetric shape is obvious. The height of the rotating part has to do with grip as well. To make sure the user's finger tips will have distance from the countertop, some height is added underneath the rotational part. To make the knob still look slim, this is done with curvature resulting in a smaller circle. This way from the top view seen, the knob seems to float above the service. Looking at the top view, the middle circle were the interface will be is a reference to a gas burner. Were with a gas burner the flames come from underneath, this is the case in the knob with the transparent part were light will shine through. More elaboration on this can be seen in the next subsection. The knob will come in different material looks. An overview of the looks and some examples of material variations can be seen in figure 72. More variations on the material looks can be seen in appendix V.

This new way of cooking on induction deserves a new user experience in terms of controlling the zones. As discussed before, to keep the surface of the countertop as clean as possible and still get more of the same feeling as with cooking on gas, a rotational knob without a fixed location was chosen. This one knob will control all cooking zones and has to have the same functionality as a standard induction hob interface. Since the amount of cooking zones can be up to the user and the knob should also be able to use for living situations, six locations on the knob can show different information according to the situation and act as a knob or pressing point.

Cooking versus living

The knob will have two modes, one for cooking and one for living. Each mode will have its own functionality and feedback. While cooking, zones must be selected, the intensity of each zone has to be able to adjust and must be seen and timers have to be able to be set. In the living mode, atmospheric light has to be adjustable and the air purifier should be able to be turned on. An impression of both modes can be seen in figure 73.

Light ring

A light ring will represent the intensity of the cooking zone that is being controlled at that moment. The looks are a reference to a gas burner like explained before. The light ring acts like the flames that are coming from underneath the burner and the light should act about the same as the fire would do while changing the intensity of the gas burner. Ideation on how to visualize this best as well as other aspects of the interface can be found in appendix W.

Control

To control the knob, the rotational ring can be used as well as the earlier discussed six pressing points. Whether these are actual buttons, the whole disc will be pressable or touch functions are used will depend on the final chosen electronics which are discussed in the next section.

Visual and haptic feedback

At first to show better were the cooking zones are, light from the air extractor will make the reflective print of the cooking zones stand out more as can be seen in figure 74. The interface on the knob will show the intensity of each zone, the zone selected, the timer option, when a pan is put on a zone and if zones are still hot in the cooking scenario. In the living scenario it shows either the intensity of the light or of the air purifier. Next to visual feedback, haptic feedback will be used as well. When turning the cooking zones on, it will buzz in a way that is similar to the ticking of gas hobs when they are put on. Next to that, when changing the intensity, for each intensity it gets higher, haptic feedback will occur so the focus of the user can be on the pan while still knowing the change of intensity of the zone. Flowcharts of the use of the system can be found in appendix X. A scenario of a typical use while cooking can be seen in figures 75 until 81.

Cooking mode

Living mode

Figure 73: Cooking and living mode of the smart knob

Figure 74: Highlighted zones by air extractor

Figure 75: At first the user picks up the interface and places it on the desired location.

Figure 76: The system will be turned on by rotating the knob

Figure 77: When a pan is placed on a certain zone, this zone will glow on the knob

Figure 78: To adjust the intensity, the ring is rotated and the light becomes more intense

Figure 79: To select an other zone, push that zone

Figure 80: To set a timer for this zone, push the timer icon

Figure 81: To adjust the time, rotate the ring

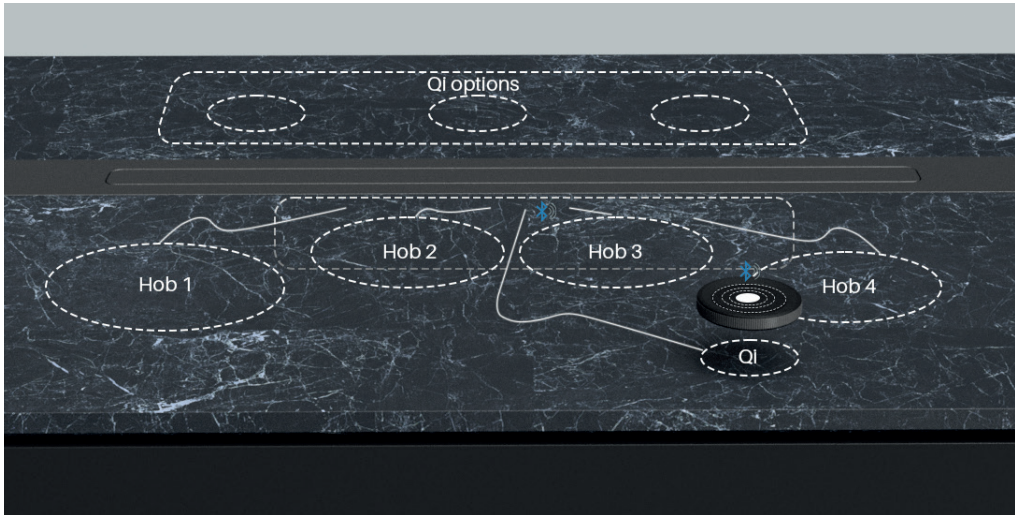


Figure 82: Electric components underneath countertop

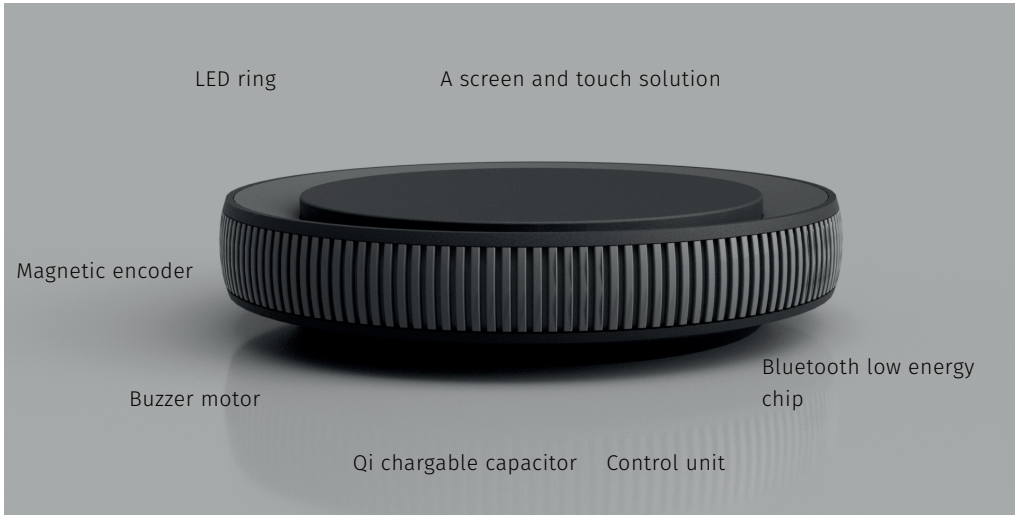


Figure 83: Electric components smart knob

For the system to work, both underneath the surface of the countertop and in the knob certain electronic components are needed. A major part of the components underneath the countertop will be dependent on the producer of the induction zones, other parts are specific to this concept and are needed to add. An expert on electronic design was consulted to help selecting the right solutions.

Underneath countertop

To make the total system work, underneath to countertop the different cooking zones have to be placed existing out of coils, control units and fans. Those cooking zones are controlled by a unit in front of the extractor hood. The Qi chargers are placed underneath the countertop as well and are also connected to the control unit from which they will get their power.

Smart knob

For the smart knob to be able to have the different functions as designed, multiple components are needed. A magnetic decoder is used to measure the rotation of the ring and the direction of rotation. A LED ring is used to lighten up the light ring. An LCD underneath a microperforated surface is used to show the interface or another solution like a touch screen will be chosen depending on feasibility. Underneath this are press buttons or capacitive touch sensors. A buzzer motor is used to give the haptic feedback. A Qi chargeable capacitor is used to get energy from the charging points, a Bluetooth low energy chip is used to communicate with the control unit underneath the countertop and this all is controlled by a control unit in the knob itself. To choose the different components an expert on electronics was consulted of which the conclusions can be seen in appendix Y. An overview of the components for the knob can be seen in figure 83.

Bluetooth communication

For the communication between the knob and the control unit underneath the countertop, Bluetooth low energy is used. As the name implies, it does not cost much energy but is still sufficient to send the information that is needed back and forth. The addition of a Bluetooth chip in the control unit gives also possibilities to communicate with other appliances. For instance if it can communicate with a thermometer, it can know the temperature inside a pan and adjust accordingly which makes it possible to cook sous vide or deep fry on a fixed temperature.

To be able to test and evaluate certain design choices, prototypes of the smart knob were made. This started with paper prototypes, after which a simple foam mockup was made followed by a 3D printed model with the LED's implemented. At last a semi functional prototype was made.

Ergonomics

To determine the size of the rotational knob, at first the knob was printed on paper in different sizes of which an example can be seen in figure 84. The document with al sizes can be seen in appendix Z. From this is was found that the outer diameter should be 85mm. This was then cut out of a foam board to check if it indeed will fit the hand nicely which it did. The next step was the first 3D print in which the outer diameter was 85mm and the diameter of the interface 65mm. An exploded view of the model used can be seen in figure 85. In this prototype, only the grey ring was able to rotate as was intended at first. While trying the prototype is was concluded the black part above it was in the way of your fingers and should rotate as well to make it more comfortable or should be smaller. The size of the ring was satisfactory. Like explained in the looks section, the fingertips would also touch the surface of the countertop with this model, for that reason the whole would be higher as is in the current design.

Looks

The looks were also evaluated from the first 3D prototype. The colors were 3D printed as at first designed. A semitransparent ring was printed to let through the light of the LEDs. The LED's were powered by USB and had a white color originally. To simulate the intended color, different colors see through paper were wrapped around the LED's until the effect was satisfactory. Jacco Bregonje which is mentioned earlier, had similar product installed in his kitchen from a possible producer Boretti might work with. To experience this I went cooking in that kitchen and took the prototype with me to see the overall appearance in a similar concept. Impressions of this can be seen in figures 86 and 87.

Next prototype

The next prototype will have the changing intensity of the LED ring and the buzzer motor integrated to test out the feedback the user will get. To measure the rotation of the ring, a rotary encoder is used since this is easier to prototype then a magnetic encoder. Other changes are a slight curve in the rotation ring.

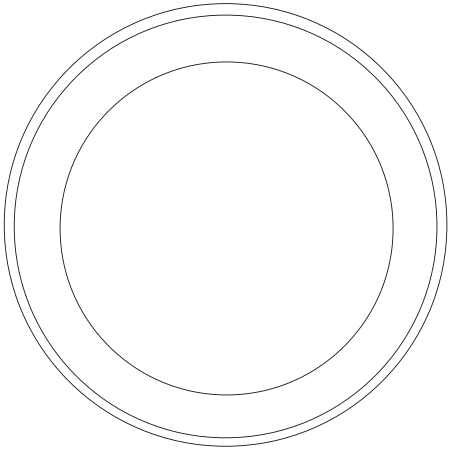


Figure 84: Paper prototype of knob

Figure 85: 3D model for print

Figure 86: Prototype during cooking

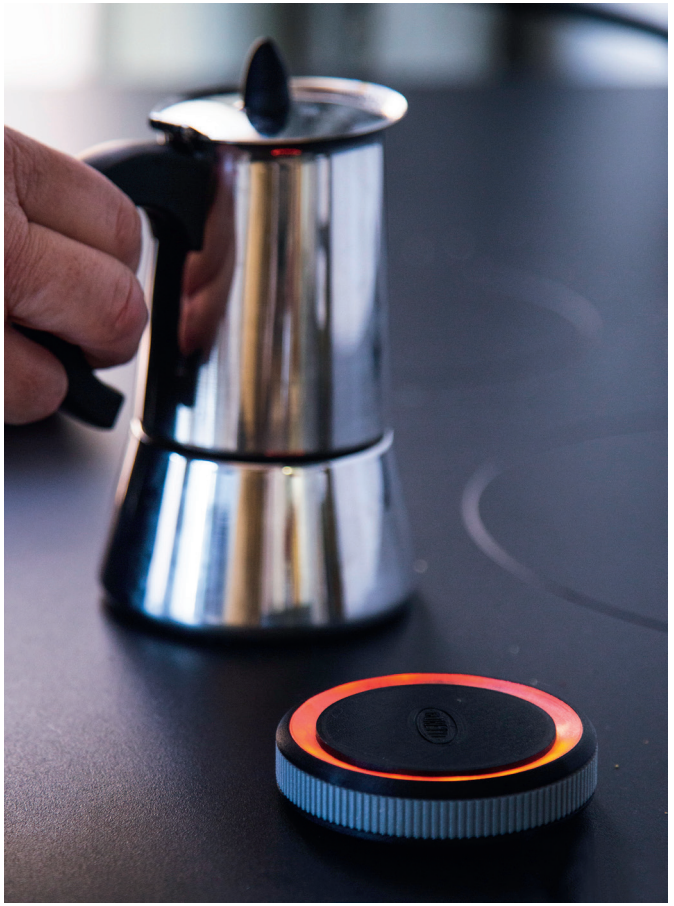


Figure 87: Prototype during making coffee

Both with the conclusions made from the previous prototype and some design choices made during the process, a newer and more functional prototype wase made of the smart knob. To lift the knob a bit of the surface of the countertop. A curvature to a smaller circle from the bottom was made so it seems to be floating above the surface which makes sure the fingertips will not hit the surface. The rotational ring has slight curvature to make sure the upper fillet of the top part is not in the way anymore as with the previous prototype. To test out if this was enough or the whole upper part has to rotate, an in between prototype without other function was made as can bee seen in appendix AA which proved the curvature in the ring was sufficient and can be the only rotating part.

The new prototype has more function then the previous one, this one does not only have LEDs in it but the rotational ring actually adjusts the intensity. When the intensity is adjusted, a buzzer motor is powered to give haptic feedback. A button is used to switch between cooking zones. This was all done with the use of an arduino with a rotary encoder, a LED ring, a buzzer motor and a button.

Two possible LED feedback ways were programmed and tested. The first one is the one as chosen in which the light becomes more intense when the intensity of the cooking zone is higher. An addition is that the color changes from red orange to yellow orange gradually as well. In this scenario all LEDs are on for every intensity. An example can be seen in figure 87. Another version that was simulated is almost the same as the first one but the difference is that not all LEDs are on at all times but also the amount of LEDs that is one are dependent on the intensity of the

Figure 87: LED feedback version 1

Figure 88: LED feedback version 2

cooking zone. An example can be seen in figure 88. The arduino code for both situations can be found in appendix AA. The first version is chosen to implement since it looks better. The second version is a bit more clear in terms of indicating the intensity but since this is also shown on the screen(s) in the reel product this will be clear anyway.

Both situations are programmed to safe the intensity of each zone when switching between zones and show the intensity of all zones in the serial monitor of arduino when connected to a computer. An example can be seen in figure 89.

To make this all work a 3D model was made and printed of which an exploded view can be seen on the left in figure 90. A translucent tooth wheel was placed above the LED ring and into an inner tooth wheel modelled on the inside of the rotational ring. For all components except the button fittings were modeled as well. Photos of the 3D printed parts with components inside can be seen in figures 91.

```
Selected zone:2
Intensity 1: 9Intensity 2: 2Intensity 3: 3Intensity 4: 3
Position: 17Intensity: 2
Selected zone:2
Intensity 1: 9Intensity 2: 2Intensity 3: 3Intensity 4: 3
Position: 17Intensity: 2
Selected zone:2
Intensity 1: 9Intensity 2: 2Intensity 3: 3Intensity 4: 3
Position: 17Intensity: 2
Selected zone:2
Intensity 1: 9Intensity 2: 2Intensity 3: 3Intensity 4: 3
Position: 17Intensity: 2
Selected zone:2
Intensity 1: 9Intensity 2: 2Intensity 3: 3Intensity 4: 3
```

Figure 89: Serial monitor Arduino

Figure 90: Exploded view parts for 3D print

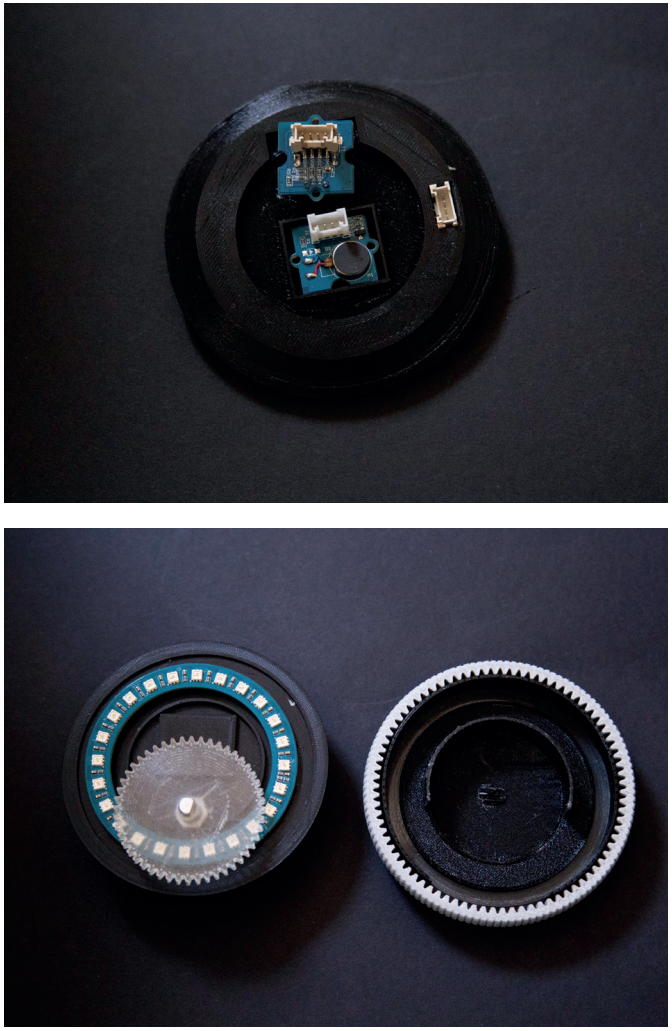


Figure 91: 3D printed parts with components

Figure 92: Final prototype knob

Figure 93: Close up of knob in simulated situation

To simulate how the product would look like in real life, the knob prototype was placed on a ceramic slab next to pans and a cutting board. Figures 92 until 94 show impressions of this.

Figure 94: Total overview of knob in use and finsihed dish

To fit both looks and function, certain materials are selected with suitable production methods for different parts of the design. Since the focus of the embodiment phase was on the smart knob, this is worked out in most detail. The materials of the induction zones are dependent on the producer and is not covered for that reason. The air extractor is not covered as well since this can be seen as a standalone product design. The things that are covered are the countertop, the accessory bar and as already pointed out, the smart knob in more detail.

Countertop
Like explained in the analysis section. the countertop will be made of a certain ceramic called Gres Porselain. The specific composition is dependent on the producer which also distinguish them from each other. Boretti will have to work with the one that has te lowest change of cracking during temperature changes. The so called ceramic slabs are pressed, cut and printed to the desires of the customer. This manufacturer is preferably also able to print the indications of the locations of the cooking zones.

Accessory bar
The accessory bar and most of the selectable accessories will be made of stainless steel sheet metal. This, because it will consist of simple shapes with continues wall thicknesses that are easily foldable or pressable and are produced in this way. The choice for stainless steel is also logical since it can get wet while using the kitchen and rust is not acceptable.

Smart knob
For the smart knob, different materials will be used for specific parts. The smart knob is split up in a casing, a rotary ring and a translucent LED ring cover (see figure 92). Next to that, it will be made water proof by using a certain material between parts.

To determine the most suited material and production method, the designer of the indoor products of Boretti was consulted to explore the current production Boretti used for knobs. The following distribution can be made;

Cheaper look and feel knobs are made of injection molded ABS with a chrome coating for instance.

Medium range knobs are made of Zamak which is die casted and can easily have different shapes. The reference given was “Nuova-saimpa”.

The more premium range makes use of machined stainless steel parts. The reference given was “Paradisi”.

The casing is chosen to make from ABS without a metal (look) coating, for this project the look and feel of the ABS itself are suited and the material has the right strength and stiffness (a Young’s Modulus of 2,09-2,75 GPa and a Yield strength of 34,5 - 49,6 MPa). The rotational ring will be made of machined stainless steel to have the same feeling and experience of a premium knob of a traditional hob. The translucent cover of the LEDs is made of a cloudy translucent ABS to make sure the light does come trough but made diffuse and the LEDs themselves are not clearly visible.

Figure 95: Smart knob materials

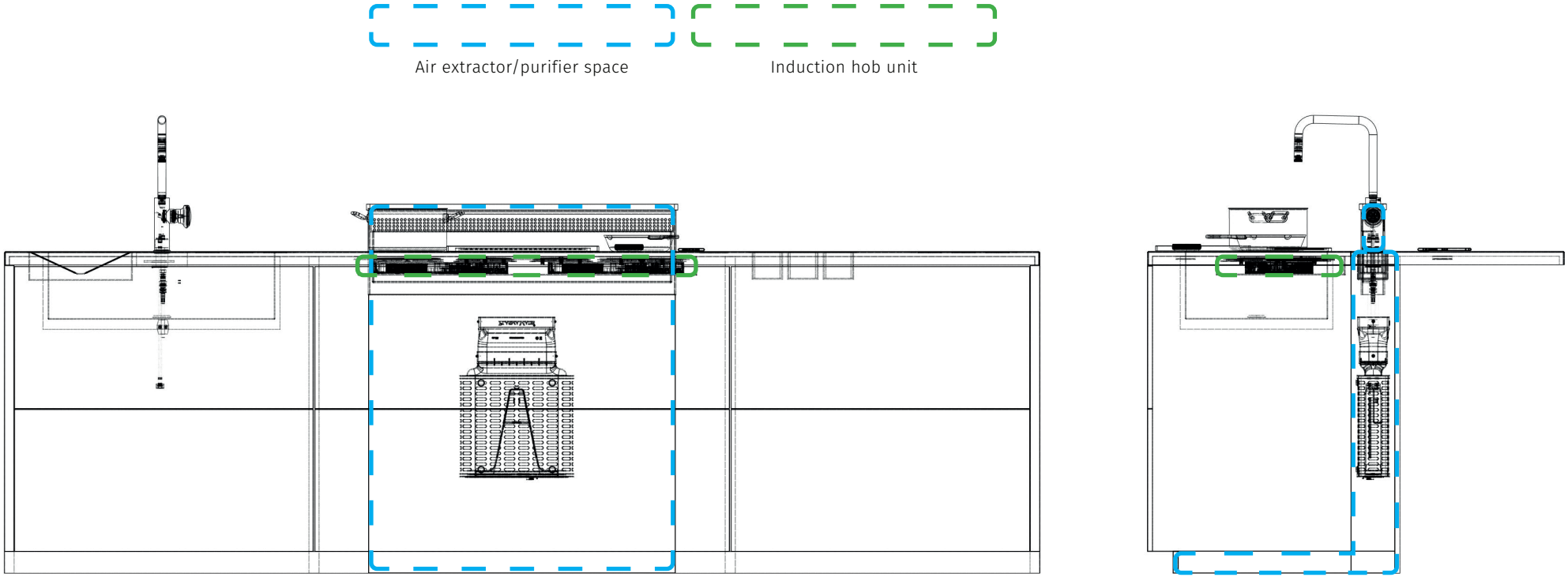


Figure 96: Space taken up by induction hob and air extractor units

Just like for the materials and production methods, the focus for the product architecture is on the smart knob. At first the consequences for the kitchen and kitchen cabinets will be discussed with placing the induction hob and air extractor/purifier. Second, the architecture of the accessory bar and one example of an accessory are shown. At last, the more in depth product architecture of the smart knob is discussed.

Induction hob & air extractor

The induction hob as well as the ceramic slab will be produced by an other party, Boretti is already considering different companies of which one can deliver both. For this reason it does not make sense to design the casing and attachment of the induction hob totally. To give an idea of size and space needed underneath the countertop, from the CAD model of the current prototype the induction zones were copied and put in the orientation of this concept with a case around it See figure 96. The induction charging points for both smart devices and the knob are attached separately. Often there is a wooden plate underneath the ceramic slab in which a fitting for the case with induction zones and control in it and the Qi charging points can be made.

Since the air extractor can be seen as an other product this is not designed into depth as well. Space is needed underneath the accessory bar for the motor, recirculation filter and the air has to be lead through outside the kitchen cabinet either on the side or front. At the end, a HEPA filter is installed to make it function as an air purifier as well. To see the space this takes up and consequences for the kitchen cabinet see figure 96. The outer dimensions of the induction hob unit are 925 x 210 x 55mm. The Qi zones have a diameter of 59 mm and a thickness of 9 mm. The space needed for the air extractor as designed right now is 920 x 80 mm and a height dependent on the height of the countertop. This all fits in a standard size with of a kitchen cabinet of 1000 mm wide. Cover plates can be used to hide the units in the closet.

Accessory bar

Just like the air extractor, the accessory bar can be seen as a separate product or even product line. The difference is that this is totally new and for that reason an example is given of one accessory. Like discussed, the bar itself is made out of folded sheet metal. It has open slots with the same size to fit different kinds of accessories especially made for this purpose. This contains standalone accessories and some in which can fit a Boretti appliance like a water tap. An example of a dish rack accessory in place is shown in figure 97. Furthermore, a charging and storage location for the smart knob is integrated.

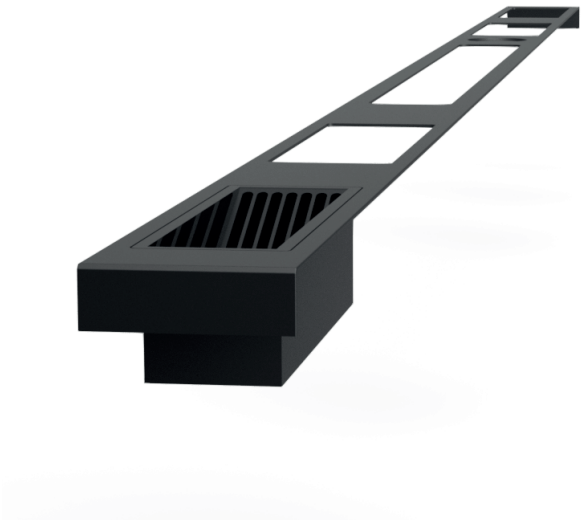


Figure 97: Accessory bar with dish rack

Smart knob

The smart knob consists of multiple ABS parts, a stainless steel part and different internal components.

A bottom part contains the coil for Qi charging and a multipolar magnet to snap on certain locations of the countertop. This part is also were the screws are inserted. Those screws are covered with a rubber layer which also makes sure the knob is more stable on the surface. See figure 99 for details of this part.

A middle part contains the PCB, BLE chip and sensor part of the magnetic encoder. The rotational ring with magnetic encoder ring slides over this part. The screws go all trough this part guided with tubes. See figure 99 for details of this part.

Between the upper and the middle part, the rotary encoder and rotational ring are located. This part can be seen in figure 98.

The upper part contains the LED strip, LED cover and screen(s). This is the part were the screws will be fastened. For now, small screens fitting the desired size of the interface are modelled in CAD, this solution has to be iterated on further. The ultimate solution would be micro perforation with a screen and capacitive touch underneath but since it is not yet clear if this is feasible, this solution was chosen for now. See figure 99 for details of this part.

To fit everything together, at first all internal components are installed on the discussed parts. Then, the cables are connected from the separate electronics to the PCB. At last everything is screwed together with the three screws. Those screws are covered with a thin rubber pad which also makes sure the knob is stable.

The internal components are based on real products, see appendix AC for the references. The screws that are used are M2 15mm. An exploded view of the total product architecture of the knob can be seen in figure 99.

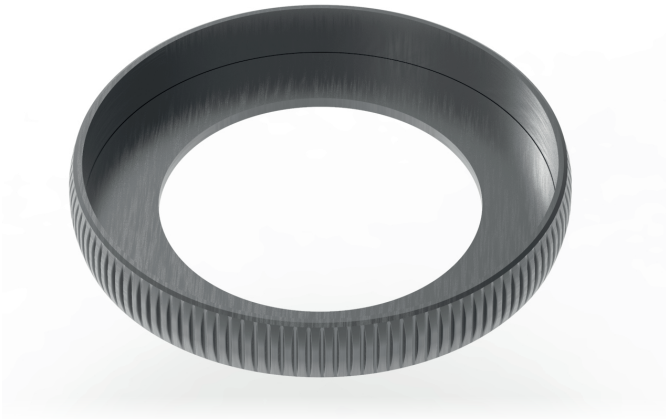


Figure 98: Rotational ring with magnetic encoder ring inside

Figure 99: Bottom, middle and upper part seperate and exploded view of total

Water tightness smart knob

To make sure no water will get to the electronics, the knob is made water tight with rubber fittings between parts. This is a method also used in professional cameras. Figure 100 illustrates the locations of those fittings.

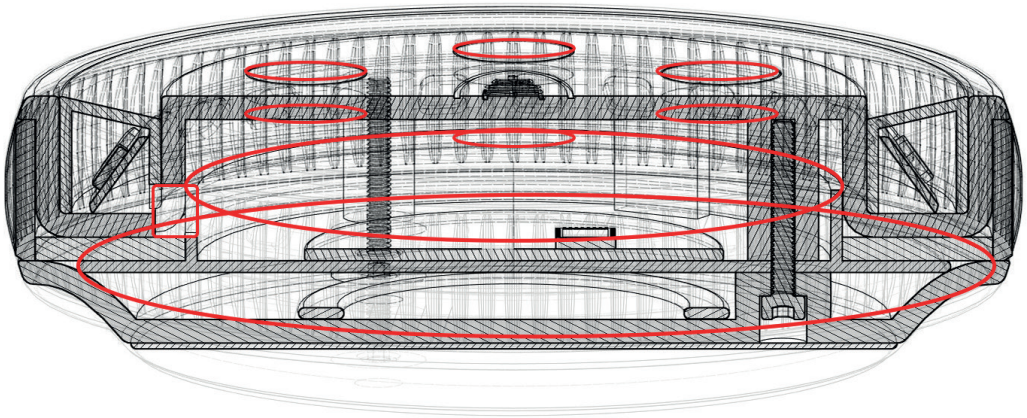


Figure 100: Water sealing smart knob

Details designed parts

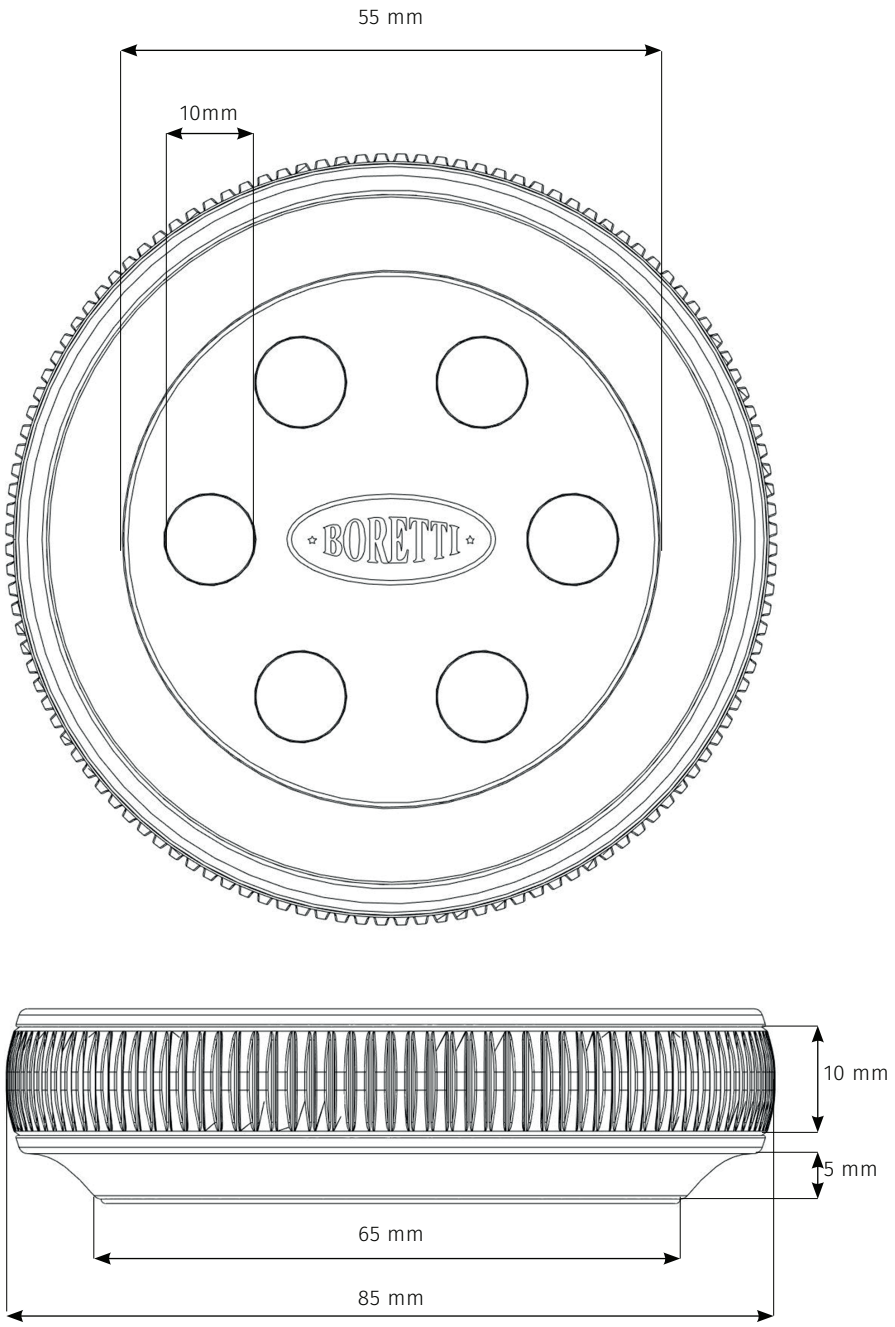
The smart knob consists of both existing components and specifically designed parts. Figure 101 shows the most important dimensions of the overall knob and intersections of the designed parts. The outer dimensions of the knob are based on ergonomics found from making prototypes and are discussed in the next section. The other dimensions are based on the size of electronics and the final looks.

The top part and bottom part are 2mm thick and designed in such a way that it can be injection molded and is releasable with a mold consisting of two parts. Those are also the parts that hold the screws.

The middle part is 1mm thick since it does not have to be as strong as the top and bottom part since they form the casing of the product and this part is inside and more protected. A slot for a cable to go to the LED ring and a slot for a cable to the charging coil are made in this part as well.

Those three ABS parts fit perfectly into each other and have the rotational ring in between them which can only rotate and not move up and down anymore when the product is put together.

At last the translucent ABS cover has a wall thickness of 1mm and has space for the cable of the LED ring to go through just like the top and bottom part. To get to this product architecture some iterations were made to improve the producibility, amount of parts and assembly steps. Earlier versions can be found in appendix AC.



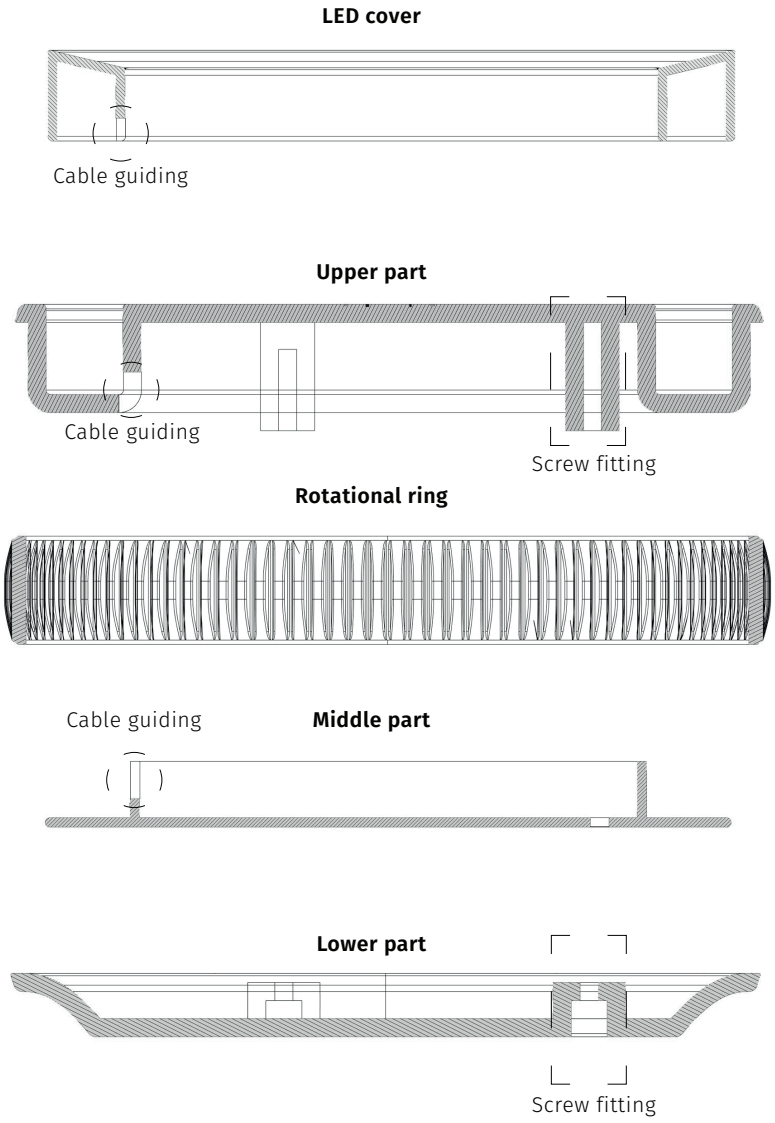


Figure 101: Smart knob dimensions and parts

Since the final design actually exists of multiple products, to support it a product placement and strategy is suggested to Boretti for future developments.

Since the final design exists of multiple parts and products working together, a suggestion to Boretti is to make a product line around it, providing different products to choose from. The line could consist out of multiple products and is called “Collezione Appassionato”. Figure 102 illustrates out of which products the line could consist with all different variations to choose from.

The first one is the unit with the cooking zones, the worked out design has four of them but it is advisable to provide a range for the costumer to choose from. This can exist of different amount and sizes cooking zones and flex zones.

Those cooking zones can be combined with different sizes and material looks of ceramic slabs.

Also the knob could exist of a range with different material looks and if needed, there could be variations on user interface suited for different target groups as well.

Different looks and sizes could be made for the accessory bar also, with a great variation of accessory products that can be integrated like spatula holders but also placement tools for a Boretti water tap.

Different solutions on air extractors either integrated like in the current design or stand alone with similar looks as the counter-top would be part of this product line.

At last with the Bluetooth chip in the control unit of the induction zones, additional appliances can be sold like a thermometer to cook sous vide.

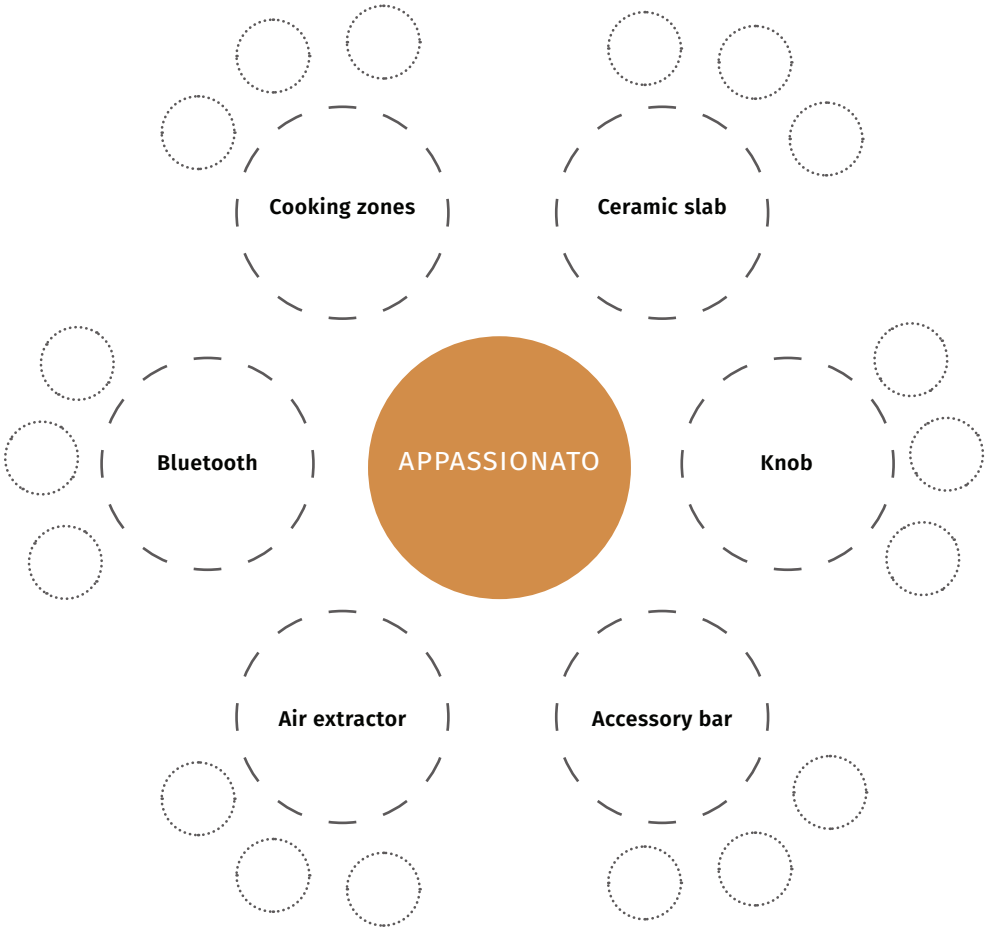


Figure 102: Overview of Collezione Appassionato

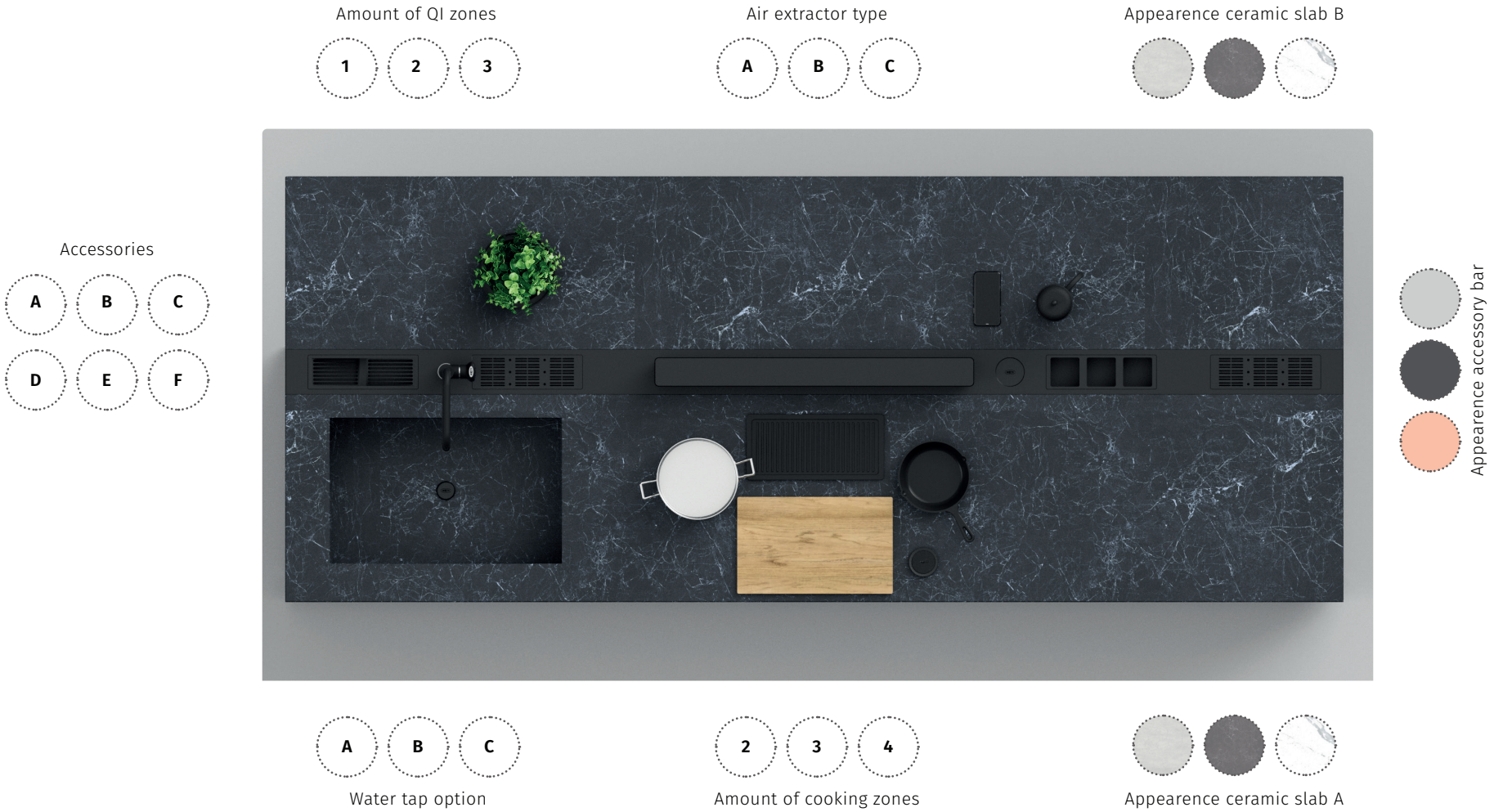


Figure 103: Overview personalisation and choices

Selling and service

The selling of the product will probably go through different channels. The whole kitchen block either in a kitchen store or with a house, the integratable accessories can be sold in the current selling channels of Boretti. Services like monthly sending cleaning tools for the ceramic and things like olive oil can be a service to consider.

Users choice

The user will be able to choose and select different options when buying the countertop with induction. Those choices will be based on the Collezione Appassionato. An overview of the choices to be made is represented above in figure 103.

To show the final design in full glory, some final renders with explanation can be seen in this section.

Figure 104: Impression of total kitchen while cooking

Figure 105: Impression focussed on smart knob during cooking

Figure 106: Detail of knob during cooking

Figure 107: Living situation

Figure 108: Material variations of smart knob

To evaluate the final design on the expected and desired outcomes, it is tested on the main drivers and requirements. If needed, further development is suggested to meet them.

To test the success of the final concept and it's embodiment, it is evaluated on the main drivers, feasibility, desirability and viability.

Main drivers

THE PRODUCT SHOULD ENTER THE MARKET IN 2021/2022 This main driver is fulfilled. The technologies used are all available already and can be implemented in time to enter the market. Working prototypes of the induction combined with the ceramics are there at Boretti and other parties. The design made by me of the smart knob is based on existing internal components and production methods and tested with slightly similar components in a prototype. A concession was made on the display on top of the smart knob to make it feasible for this timeframe by choosing small screens or one larger one. Ultimately it would have been hidden underneath a microperforated surface but these technologies are still in development and can be integrated in the next generation of this product.

WHEN NOT COOKING ON THE INDUCTION, THE SURFACE ABOVE CAN BE USED FOR OTHER COOKING PURPOSES By having designed a separate smart knob which can be put away after usage, the surface has no fixed interface in it and can be put to a different use when not cooking on it. The cooking zones are only slightly visible when the system is not turned on and will not distract the user. This surface can now be used for making dough, cutting or other cooking purposes.

THE INDUCTION COOKING HAS TO BE SUITABLE FOR ALL TYPES OF COOKING IN PANS When selecting the right producer of both the ceramic slab and the induction hob, ideally the same producer, the surface will not crack. The design made has a sufficient amount of zones, size range and orientation to suit all types of pans. When adding a discussed Bluetooth connected thermometer, it even becomes possible to cook sous vide or deep fry with a stable temperature in pans.

THE DESIGN HAS TO PROVIDE THE POSSIBILITY TO INTEGRATE AN AIR PURIFIER The accessory bar provides the ultimate solution to place a downdraft air extractor without having to break up the countertop. With using a recirculation filter and a HEPA filter it will clean the air as well. To see if it can compete with the result of a traditional air purifier this has to be tested.

THE DESIGN OFFERS THE POSSIBILITY TO INTEGRATE APPLIANCES AND ACCESSORIES FOR BOTH LIVING AND COOKING The most important solution designed to make this true is the addition of the accessory bar. Simple accessories can be integrated but it also provides the possibility to integrate complete appliances like a Boretti water tap. Next to that, the option to integrate Qi chargers is given. At last, the presence of the Bluetooth chip in the control of the induction zones provides the possibility to connect appliances like a thermometer.

For validation of the full list of requirements, see appendix AD.

Feasibility

Like discussed in the main driver of entering the market in 2021/2022 the total design makes only use of existing components, technologies and production methods and is therefore feasible. Whether the ceramic slab will not crack after a lot of usage in high temperatures and if the solution for the integration of an air purifier will work as good as desired has to be pointed out by longer testing in the future. The way of control with the smart knob is one hundred percent feasible.

Desirability

One thing that comes forward when asking passionate home chefs wat is missing in a induction hob is rotational knobs like with a gas hob. This was confirmed in the interview with a specialized cooking store and visitors of GLUE Amsterdam. This is solved with the introduction of the smart knob. The smart knob has more references to a gas hob like the light ring resembling the fire of a gas burner. Furthermore, cooking on gas will be banned in the Netherlands from 2050. Induction for this reason amongst others is getting more popular. This is true for the Netherlands as well as other countries like especially Japan and western Europe as pointed out in the analysis section. The design offers more freedom in use of space and personal taste by making the hob disappear underneath the countertop. It follows the trend of the kitchen and living room being less of a separate thing by including functionality and styling in the kitchen.

Viability

During the change from gas to induction and the trend of people getting smaller houses for higher prices in big cities the product design will have even more right of existence in the future. The amount of cooking zones or changing them to flex zones and the way they are indicated and controlled might have to be changed in the future but this can just be next generations of the design.

To sum everything up and give answer to the questions asked in the original assignment, a conclusion was written.

To conclude the project, different points will be discussed. The project brief and expectations at the beginning of the project will be compared to the final project, the state of different aspects of the design are discussed and at last, important findings during the total project.

The design case provided by Boretti was to translate a current concept of a standalone oven with a induction hob on top using a different type of ceramics than glass to one integrated in a countertop. The idea was to research the context, market and users to find the needs and inspiration to make an integrated design. The expectation was to end with about three concepts of which one is fully worked out in terms of product architecture and documented in CAD and (partially) prototyped.

The overall assignment is fulfilled. An analysis phase was done from which ideas leading to three concepts were created of which one was worked out into more detail. What I did not expect at the beginning was to design a new way of controlling the zones instead of choosing the right traditional solution. This resulted into designing a smart knob which is almost a product itself. The same is true for the accessory bar which was not foreseen at the beginning. Furthermore, the product architecture of the induction unit will be dependent on the chosen producer to work with. This all resulted in a better concept then expected but not enough time to work out the product architecture of all different parts. A focus was chosen being the smart knob which is worked out in most detail and prototyped. The other parts of the concept are worked out a lot less but proven to be feasible and make it believable the total design will be possible to work exactly as designed.

As explained, there was a focus on the smart knob for the embodiment phase so this one is worked out the most. The exact internal components will still have to be decided which can be done best together with an electronics expert or electronics designer. From this, the exact product architecture has to be changed slightly probably to fit all components and an iteration can be done to make it better producible. The overall state of the design of the smart knob is already quite far since the dimensions, user interaction , materials and a suggestion of components and product architecture are there.

The other parts of the induction and ceramic slab mostly need proper cooperation with producers for Boretti and together find the best solutions.

The accessory bar and combined air extractor and air purifier are both on concept level and have to be worked out further in terms of product architecture material and production.

During all phases new findings came forward. Starting with the analysis, at first shift of the market for Boretti was an important finding. They will have to collaborate with new companies, use new selling channels and provide other services. Secondly, the new ways people are living was an interesting finding. People are living more and more in smaller spaces, open spaces or even in shared living environments. Multifunctionality of space is becoming more and more important.

The orientation and distribution of the cooking zones was concluded to be improvable in comparison to the traditional ways. With the restrictions of the size and shape of the glass plate which is normally on top of an induction hob gone, more freedom is created for the locations of the cooking zones. The user being in the center of the zones and having space for a cutting board and control interface in the center with cooking zones around it was found to be a better solution.

Stepping away of a traditional way of control for the cooking zones to a new one is one of the main important findings and delivering an extra USP to the concept. At the same time it has more the looks and feels of a knob for a gas hob but is still more modern and flexible than a tap interface traditionally used in an induction hob.

At last the idea to build a whole range around this new induction hob type but also integrational products in the countertop is an important conclusion that can give Boretti direction in what is possible with this new concept and how to elaborate on it in the future.

To make the project a success this section gives some recommendations on the next steps to be taken after this graduation thesis.

The first recommendation is to not see the concept as one product but as a totally new world with a range of products that changes the experience of a kitchen completely.

To test if different assumptions made or conclusions of small tests during the project are correct. Some more user research and evaluation is advised. At first additional research can be done on the desires of users when it comes to the amount of cooking zones, the size of the cooking zones, the possibility of flex zones and the orientation of the zones. A setup for a test on the orientation of the cooking zones was already made and can be found in appendix AE. Unfortunately, the test could not be done with the right people during restrictions as a result of the COVID-19 pandemic.

Furthermore, since the way of control that is designed is something new, user tests should be done to find out if the use is intuitional and found preferable by the consumers.

The demand for an air extractor to be combined with an air purifier should be evaluated as well after which it can be worked out in terms of product architecture, materials and production. The same counts for the accessory bar.

It is advisable for Boretti to cooperate with a producer that can deliver both the ceramic slabs and the induction hob itself which is already true for a party Boretti is considering. It is important for Boretti if this producer still offers enough space for design choices and implementation by Boretti to make the final product as intended.

The last advice is to invest time and money in market research looking at possible cooperation's, new selling channels, services and new target groups.

Looking back at the project, many things were different then could be foreseen. Starting with the pandemic which resulted in a delay of the project, working from home and no or little possibility to test with users. Although these are not the best times, it did force to user my strength as a designer and think in solutions instead of problems. The working from home issue was tackled by arranging an office and the beautiful Van Nelle Fabriek with people that experienced a similar missing of working in an environment with other people. The new way of meeting, being video meetings was used to meet with people I otherwise would not. An at last, the time as a result of the delay was filled with being a Teaching Assistant at the faculty which brought me a lot as well.

Like discussed already, the outcomes of the project were different than expected by myself at the beginning. This resulted in having to make choices on a focus. A big learning experience is to make the right choices at the right time and just keep discussing with the stakeholders to make sure the focus is on the right thing.

I want to thank both the supervisors from the TU Delft and everyone from Boretti for this experience and all the help that was provided. Erik Tempelman, being my chair and the giver of the opportunity to teach at the faculty. Him as a coach and a course coordinator to work for were both a pleasure. Martijn Haans being my mentor and my all-time teacher for about every drawing course followed during the bachelor and master which was a pleasure as well.

Alexander van der Heijden, which was my first contact person at Boretti and suggested this project which I am very thankful for.

Jacco Bregonje, the designer of the indoor products of Boretti with whom I have had many meetings, cooked together on a prototype and was an excellent coach during the project. I Really enjoyed working together and are looking forward to future cooperation's.

Nico Admiraal, the (former) product manager of Boretti, whom was present at a lot of meetings as well. Nico gave good input from a slight different perspective then Jacco which really helped. Nico was also a great pleasure to work with.

At last the whole company of Boretti B.V. which gave me the opportunity to do such a great project and support in the way they could even during the Corona crisis.

Articles, books, presentations and journals:

- Boretti (2019): Strategy 2020 channel management, Boretti, Amsterdam, the Netherlands
- Boeijen, V. A., Daalhuizen, J., Schoor, V. R., & Zijlstra, J. (2014). Delft Design Guide: Design Strategies and Methods. Delft, The Netherlands: Laurence King Publishing.
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- Appliance DESIGN. (2018, January 1). The Growth in Use of Induction Technology within Home Appliances. Retrieved 3 July 2020, from https://www.assemblymag.com/articles/94844-the-growth-in-use-of-induction-technology-within-home-appliances

The following internet sites where accessed to obtain background information:

- http://sharedlivingenvironment.nl/
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- https://www.dbkeukens.nl/keuken-inspiratie/keuken-ontwerpen/hoogte-en-diepte-aanrechtblad#:~:text=Standaard%20hoogte%20en%20diepte%20aanrechtblad%3A%20170%20%2D%20195%20cm&text=Dan%20is%2095%20cm%20een,mensen%20een%20ideale%20grijpdiepte%20is.
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- https://www.rijksoverheid.nl/onderwerpen/duurzame-energie/vraag-en-antwoord/hoe-lang-kan-ik-nog-koken-op-gas
- https://www.rvo.nl/sites/default/files/2014/10/Infoblad%20Ventilatiesystemen%202014.pdf

Image sources:

Figure 4: Boretti oven fromt the Maggiore collection:
https://maggiore.boretti.com/collections/ovens/products/boretti-maggiore-multifunctionele-oven-60cm-marmer

Figure 5: Schematic overview induction principle:
https://www.kitchenotic.com/wp-content/uploads/2020/06/Untitled-1024x671.png

Figure 6: ATAG induction hob with flexzones:
https://www2.atag.be/collectie/producten/000000000000436492_0001

Figure 7: Adaptive space from House documentary:
https://www.alamy.com/hong-kong-architect-gary-chang-folds-a-sofa-to-reveal-a-double-bed-in-his-32-square-metre-apartment-in-hong-kong-january-28-2010-after-three-decades-in-the-same-boxy-dwelling-chang-grew-up-in-he-has-come-up-with-an-innovative-answer-to-the-increasingly-cramped-lives-of-many-urban-dwellers-the-science-fiction-like-domestic-transformer-picture-taken-january-28-2010-to-match-reuters-life!-hongkong-apartment-reutersbobby-yip-china-tags-society-image379425032.html

Figure 8: Example render Lttle C project:
https://littlecoolhaven.nl/

Figure 9: Example floorplan Little C project:
https://littlecoolhaven.nl/

Figure 10: Gaggenau 400 series:
https://divinedesigncenter.com/gaggenau

Figure 11: Boffi kitchen design with integrated gas hob:
https://nl.pinterest.com/pin/815010863799818324/

Figure 12: KitchenAid chef sign:
https://www.uw-keuken.nl/product-kitchenaid-chef-sign-kookmodule/

Figure 13: Arclinea kitchen design with integrated appliances:
https://www.arclinea.com/eng/

Figure 14: Air extractor and lamp in one from WaveDesign:
https://www.apparatuurplanet.nl/wavedesign-217621-afzuiglamp-

82cm-kleur-naar-keuze-interne-motor-led
Figure 15: Current design of Hubstone:
https://www.hubstone.it/index_en.html

Figure 16: Shared living environment:
https://www.slideshare.net/burtonlee1/max-von-der-ahe-jordi-subiras-coworking-spaces-betahaus-berlin-barcelona-stanford-engineering-mar-2-2015

Figure 17: Passionate home cook:
https://www.pexels.com/photo/person-holding-brown-wooden-sticks-4252773/

Figure 18: Living in a studio:
https://www.dingenvoorvrouwen.nl/lifestyle/verhuisd-creeer-gezellig-thuis/

Figure 19: Family:
https://www.beko.com/ng-en/Blog/Kitchen-Inspiration/How-to-design-a-family-kitchen-that-inspires-quality-time

Figure 20: Impression of RAK ceramics:
https://www.bellabathrooms.co.uk/rak-amani-marble-dark-grey-full-lappato-tile-1200-x-2400mm.html

Figure 24: Example of current sous vide solution:
https://www.amazon.com/Anova-Culinary-Precision-Cooker-Renewed/dp/B07WC1ZRRB
Figure 68: Example looks ceramic slabs from Laminam:
https://www.laminam.com/en/

External CAD models:
http://www.grabcad.com

APPENDICES

AN INTEGRATED INDUCTION COOKTOP DESIGN

Integrated Product Design master thesis - Jeroen van Rijnberk

Appendix

APPENDIX A: PROJECT BRIEF

Carrara: New way of cooking on induction

project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 20 - 05 - 2020 18 - 11 - 2020 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

This graduation project will be about a new way of cooking on induction with Boretti being the case owner. This new way will use some kind of ceramics instead of glass which can have the looks of marble or nature stone for instance. In this way, instead of having a black glass surface in your kitchen it can look the same as your counter top and will be much more integrated. Boretti already has a concept of a standalone oven with induction hob on top that uses this new method. The thing I am going to do is developing a version in which it is totally integrated in the counter top. The induction hob when it is not used to cook on can then also be used as normal counter top space. The kind of kitchens this design is for can be multiple. One of the options is an open kitchen and with this design making it possible to connect the living space and kitchen more to each other. Another thing could be small kitchens in which the extra counter top space can be really welcome. The chosen direction for this with follow out of market research.

Boretti being the case owner is also one of the main stakeholders in this project. At the moment they have many kitchen appliances. Ranging from hobs to coffee makers, refrigerators and barbecues. This all done with the Italian kitchen lifestyle as their main value. For them, this project could help expanding their market and also differ themselves more from others with a new way of cooking. Instead of selling products that are also more or less are available in other styles from other brands, they now can have a totally new product of their own. Next to just selling a new product it can also lead to new corporations with kitchen sellers for instance, since the hob will be integrated in the counter top of a kitchen. Also, Boretti could think of a service of maintaining this integrated hob.

Next to Boretti, the possible end users are stakeholders as well. At the moment they probably have a gas hob or a traditional induction hob. These hobs take in space, are very visible and do not much represent of a connection between the living room and kitchen. In the case of an open kitchen with a kitchen island, it can be desired by the end user to have a hob which is more integrated in the style and gives more of a connection between the living room and kitchen. Both for those people but especially people with smaller kitchens extra workspace on the counter top is much desired. They can use a hob on which you can cut things or whatever you like when you are not cooking on it.

Other stakeholders are the possible manufacturers and resellers Boretti may have to work with when making and selling this new product. For them the main value in this is expanding their markets and delivering a new experience to their customers.

Summarizing, this project can give a lot of opportunities for different stakeholders. It can give extra space in the kitchen. It is multifunctional, when the hob is off it can be used as extra workspace, other functions like an air extractor can be added as well. Next to that it gives the opportunity to have a more personal and integrated style in your kitchen and connection to the living room. Another main opportunity is that since the product is new, we can design the experience totally. Furthermore it is better for the environment then gas hobs and perhaps if executed properly also better then the current induction hobs. Limitations for the end result are the properties of the material that is being used at first. Next to that, the amount of money that can be spend and the willingness of target group to invest in a totally new counter top can be limiting.

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introduction (continued): space for images

image / figure 1: Current concept of Boretti

image / figure 2: New concept idea as starting point for this project

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The end goal of this project is tackling al the problems needed to create a well integrated design of this new way of induction cooking. For this, multiple subjects need to be researched, analysed and ideated on.

To make the right choices on all topics, the market, the company and possible user groups need to be researched. Just as the way and through which channels Boretti will sell and market this product and whether or not to provide a service with it has to be tackled partly as well.

The user experience will be one of the main important things of the project because the product is new and the experience can still be shaped. Since the idea is that the hob will be less dominant in the kitchen, the interface should perhaps be as well. Questions are things like if it should be visible all the time or just when cooking on it for instance. Safety issues will also have to be taken into account to solve this. Next to the interface, other functions might be added as well, like air extraction for instance. Ergonomics and looking direction are other topics that will be covered.

Another topic is the material that is used. Since it is new to use this kind of ceramics for induction cooking, research should be done. The durability, cracking, finishes and more are subjects that will be researched. Quite some testing and research is already done. For this reason the results and information has to be retrieved, analysed and built on.

Integrating all the different needed parts in such a way that it is easy to install and also easy to repair is another issue to be tackled. The product architecture needs to be worked out well and choices have to be made and research has to be done on whether it is possible to integrate the hobs in existing counter tops as well or if Boretti has to sell the total package with counter top included.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

During this project I will design a product in which a new kind of induction hob is integrated in, and has the looks of a counter top. This product will deliver a personal style which makes a connection between the kitchen and living space and offers extra workspace on the counter top when not being cooked on.

At the end of the project I expect and aim to deliver the following:

A set of about three concepts/configurations from which at least one is fully worked out in terms of product architecture, needed parts, materials and UX. For this product design the conclusions are also drawn about the user group and the service Boretti will or will not provide with this product.

Those concepts and final worked out design(s) will be based on a research phase on the market and company, a research phase on the material and a complete and well performed exploration of ideas, possibilities and configurations. The ideas will be tested and prototyped when needed. At least the final design will be worked out in CAD and (partly) prototyped.

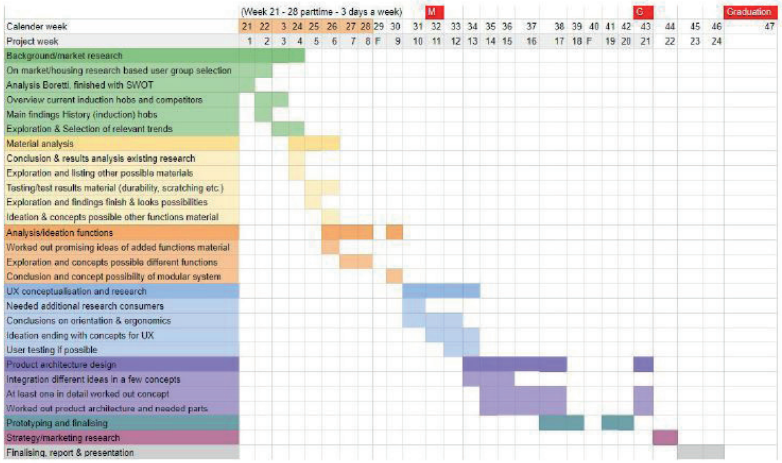
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 20 - 5 - 2020 18 - 11 - 2020 end date



The approach for the planning was to at first divide it in the main phases and topics that will happen during the project. Those different phases are then divided in tasks and topics as far as possible for now. Since the topics and tasks later on in the project are going to be based on the different outcomes of the earlier stages, the last phases are in less detail for now.

The first weeks shown in orange in the calendar week section will be part time because of a job as teaching assistant at the faculty. For this reason in those weeks I will be working on the graduation project for three days a week. Calendar week 29 and 39 will be a week of.

The embodiment phase (product architecture and prototyping and finalising) will be to much work to do entirely. To still deliver the aimed solutions and results, meetings followed with decisions on focus points will be held with the client.

The important meetings can be seen above, in the first week there will be a kick of meeting, in calendar week 31 the mid-term meeting, in calendar week 42 the green light meeting and calendar week 46 the graduation.

Due to the current corona crisis the possibility to have meetings ,prototype and do user research is hard to predict. This will probably have influence on the planning and might result in changes during the project. To solve this, based on discussions with the supervisory team, the client and my own view the planning will be iterated on when needed.

TU Delft

Personal Project Brief - IDE Master Graduation

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

To start with my motivation to do this project is at first that cooking is one of the things I really like to do in life. This combined with a link to interior design really covers my interests. Next to the topics the project covers it also gives the opportunity to work on something entirely new and really bring to practise the skills learned as an IPD student and make an integrated product design with a developed product architecture and experience.

For this the competences that I want to prove are the things like being able to make a well designed working product architecture, make the right material choices for structure and looks, being able to make good looking and well communicating sketches and CAD models and making working prototypes.

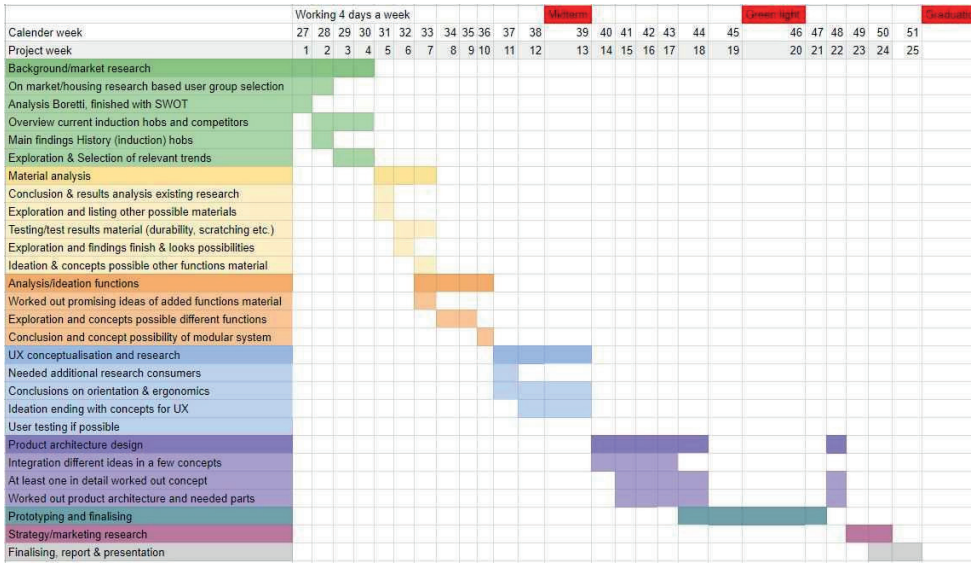
Competences that I want to improve on or learn are things like market research, UX design and user testing, Knowledge about materials combined with heath theory, production and company structure and experience.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

A last remark on this project brief is that as everybody know, we are in a crisis. This crisis already had and will have impact on the possibilities and scope of this project. For this reason changes in regulations and rules during this project can or will have influence on the project and might result in a slightly different project then is described in this project brief.

With the cause of some internal changes in Boretti during the COVID-19 virus, the start of the project had to be changed and a new planning was made which can be seen below. Later in the project it was decided to change the final graduation date to four weeks later due to extra work as a Teaching assistant on the faculty.



Like explained in the report, the SWOT analysis was done in a rough and quick way just to get some more insights in the company. To do this, a list of competitors was made, a list of products Boretti has in their product portfolio, their values were analyzed from an internal presentation and trends were listed. Together this formed the SWOT matrix in the last page of this appendix.

Competitors	Product portfolio
Bosch	Stoves
ETNA	Ovens
Miele	Dishwashers
ATAG	Fridges
Steba	Heaters
Whirlpool	Barbecues
AEG	Gelato
Hotpoint	Tostapane
Smeg	Air extractors
Electrolux	Wine coolers
Princess	Water taps
Inventum	Mixing and cutting
Siemens	Coffeemakers
Samsung	Water cookers

Tempting Recognizable Contemporary

Unique Iconic design Inspiring

Italian origins Authentic Forgiving

Famiglia

Hospitality Emotion Creativity

Enriching people’s lives

Inviting Passion Social

Buon Gusto

Brand DNA

International Italian Lifestyle

BORETTI

Service

High quality Excellent materials

Easy in use

Professional Italian manufacturers

Indoor - Outdoor - Lifestyle International

SWOT

Strenghts

Network

Brand name

High end

Recognizable

Innovative

Big product portfolio

Not pinned down to a certain production method

“Weaknesses”

Specific user group

Expensive

Opportunities (trends)

Facial recognition

Modular systems

IOT

Self learning systems

Minimalism

Eating healthy

Intelligent and smart places

Integrated style

Kitchen islands

Smart kitchen appliances

“Woonkeukens”

Integrated air extraction

Natural materials (-looks)

Shared living

Foodprep

Smart homes

Multifunctional furniture

Threats (trends)

Scandinavian style

Order food online

Back to basic

In the three new built projects that were analysed, the discussed modern house types were observed and special needs were listed of one example for each modern house type. Next to that, the special needs of people that live in a shared living environment were analysed. Note that these are observations coming from someone that is not an architect and are assumptions based on what was seen in the floorplans.

Loft

Special needs

Because of the open spaces the air extraction is really important to prevent smells in the bedroom etc. Since the whole layout is about connection, the kitchen will be an important part of this as well.

Example floorplan Little C

High end appartement

Special needs

No particular special needs, it will depend on the size, size of the kitchen and type of people living there. Expected types of people range from: Milenials, couples and small families.

Example floorplan Amsterdam Vertical

Maisonette

Special needs

No particular special needs, it will depend on the size, size of the kitchen and type of people living there. Expected types of people range from: Milenials, couples and small families.

Example floorplan Amsterdam Vertical

Penthouse

Special needs

Because of the big terrace, a kitchen with "connection" to outside might add value. Next to that, most of the time this is a big property which will likely come with a big kitchen ass well.

Example floorplan Little C

Studio

Special needs

In a studio, both multifunctionallity and air extraction will be of importance since it is a small and open space. Since this type of house will only be for one person or a maximum of two, the kitchen and hob will be small.

Example Hefkwartier

Shared living

Special needs

The space and therefore the kitchen will need to be flexible and suited for multiple people at the same time. Perhaps when not being cooked on, the kitchen/countertop should even serve an other function like a workplace.

Impression

Arclinea

Boffi

Marone + Mesubim

APPENDIX E: STANDARD SIZES KITCHENS

To make all designs based on logical sizes, standard sizes in kitchens are found from different websites. Those sizes include countertop height and thickness and standard kitchen cabinet sizes.

Countertop
Is your height between 170 and 195 centimeters? Then 95 cm is an ideal height for your counter top. The sink is also more ideally located at this height. 60cm is the standard countertop depth as 60cm is an ideal grab depth for most people. (DBkeukens)

The actual thickness of the ceramic countertop will be dependend on the producer. To make it look thicker mitered edges can be made. Popular thicknesses are 10mm, 20mm and 30mm.

Kitchen cabinets
The width of wall cabinets often vary from 30, 40, 45, 50 to 60 cm. Base units also vary and are often available in the following width: 30, 40, 45, 50, 60, 80, 90, 100 and 120 cm. (Keukenconcurrent)

The standard dimensions of the height are often between 45, 75 and 90 cm. (Keukenconcurrent)

APPENDIX F: INTERVIEW KOOKPUNT

To get more insights in the cooking market, an expert working at the Kookpunt which is a specialised cooking store in Rotterdam was interviewed. Since it was a long conversation, the main conclusions are listed below:

- People have the urge for an induction hob with rotational knobs.
- She really noticed a shift from people preferring a gas hob to people preferring an induction hob.
- She was not a fan of integrated air extractors because they often do not work as good as traditional hoods, except from brand like Berbel.
- She was enthusiastic about recirculation air extractors also available in furniture like designs.
- Most people prefer a combination between normal cooking zones and one flex zone.
- She showed me some innovative products like the Chef Sign from KitchenAid.

APPENDIX H: FIRST VERSION LIST OF REQUIREMENTS

1. The product must be suited for all types of cooking in pans.
2. The ceramic top layer must survive temperatures of 200 degrees Celsius (Pan deep frying).
3. The induction system should automatically be turned off when the temperature is getting to high (e.g. when dry cooking).
4. The system should indicate when the surface is hot after cooking and show it to the user.
5. The system has to be able to detect the presence of a pan.
6. The intensity of the cooking zones must be visible during cooking.
7. The combination(s) of cooking zones and flex zones must be customizable by the customer.
8. The biggest cooking zone must be able to produce 2100 Watt in normal modus and 3000 Watt in booster modus (Based on BI90MAT induction hob from Boretti)
9. The product should meet the safety regulations of cooking on induction.
10. The surface must not scratch or get permanently dirty/colour change by being cooked on like intended.
11. The surface must be cleanable with a wet cloth.
12. A module or the whole system of induction zones must be able to be placed and removed easily (with maximum of 3 steps) for easy placement and repairability.
13. The lifespan of the product must be at least 5 years after which only certain modules have to be replaced in a worst case scenario.
14. The costumer has to be free in choice of own kitchen design (using a countertop of party collaborated with) in which the induction system and possible other options can be placed at desired location.
15. A communicating air extractor must be able to integrate/ bought.

Ambient light

Wine

Living

Plants

Sitting around

Other

Music

Wireless charing

Writing

Working

Lighting

Coffee (warm holder)

Holding phone, book etc.

Living

Integrated functions

Types of cooking on induction

Different amount and sizes of cooking zones

Modularity

Integrating extractor yes/no

Other possbile intergrated functions

Teppenyaki grill etc.

Movable induction unit underneath countertop

Teppanyaki

Smoking

Cooking

Air extraction

Wok solution

Cutting , knifeblock

Sous vide regulation

Extraction

Cooling

Air

Purifying

Parfume

Warming

INTEGRATED FUNCTIONS AND TECHNOLOGIES

Interactive light projection - Show cooking zones and/or use for control

Using induction for charging devices as well

Plasmafilter integratable in about every air extractor

Interesting features to integrate from other products

Integrated slow cooking and deep frying devices, combination between induction and gas for other countries

Sous Vide - integrated through temperature measurement directly on induction

Temperature sensor - safety for cracking material

Pan detection- location and size

Technologies integrated in induction system

Temperature sensor - Cooking sous vide without extra device

Teppanyaki

Sous vide

Cooking

Grill

Types of cooking on induction

Wok

Frying

Sauté

Stewing

Deep frying

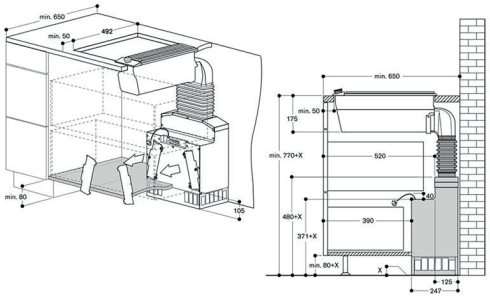
Solving heat distribution

- Sufficient material
- Heat zones with conductive materials integrated possible? Little pieces mixed in the ceramic
- Heating element making sure the heat can “Flow” away instead of hard line between hot and cold.
- Other materials on top : Extra finish?, needed extra unit in between pan and hob.

Technologies

Integrated extractor hood

- Makes the whole more independent and free.
- Does take up a lot of space beneath countertop, see Gaggenau example below



Pan detection

Pan present and size meerder partijen met patenten op versies hiervan , Detecteert Boretti ook grootte?:
- With magnetism and sensing the capacitance, it is possible to detect both the presence and the “size” and location of the pan.

Pan temperature:
- Temprature sensor integrated in electircal system beneath working service
- Temperature probes

APPENDIX J: CONSULTING YU SONG (AN ELECTRONICS EXPERT)

Yu Song was consulted to find out if it is possible to use the induction zones for both charging your smart device and cooking on it. He told in theory it was possible but the following things have to be taken into account:

- Number of turns in the coil
- Power applied to the coil -> Seems to be main issue for charging on current hobs, lowest power is 10 times higher then for charging (will fry electronics)
Qi charger 15W
Induction 120W - 2000W
- Frequency of the voltage

Time

Temperature

Air

Intensity

Feedback

Sensing pan

Ligth

Sliders physical

Push buttons digital or physical

Controlling heat

Turning knobs

Sliders digital

UX possibilities

Digital

Cooking zones

Analog

Screen

Projection

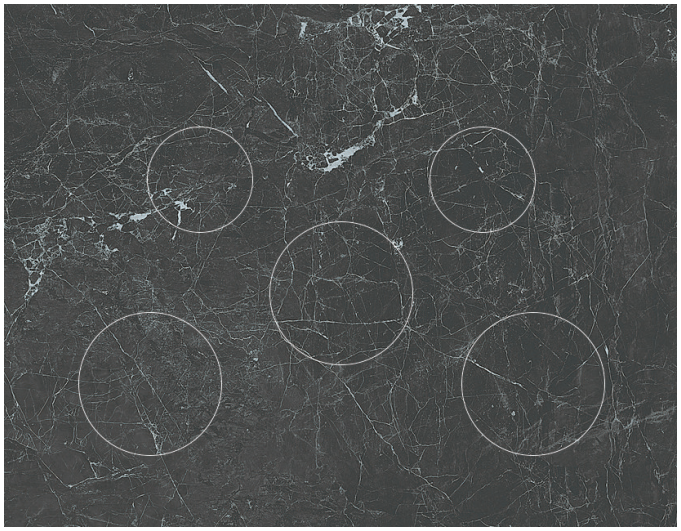
Digital

Interface

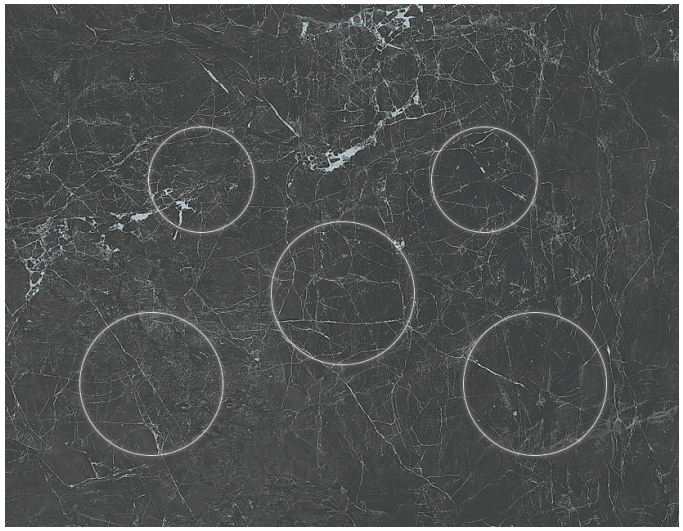
Screen

Analog

Projection

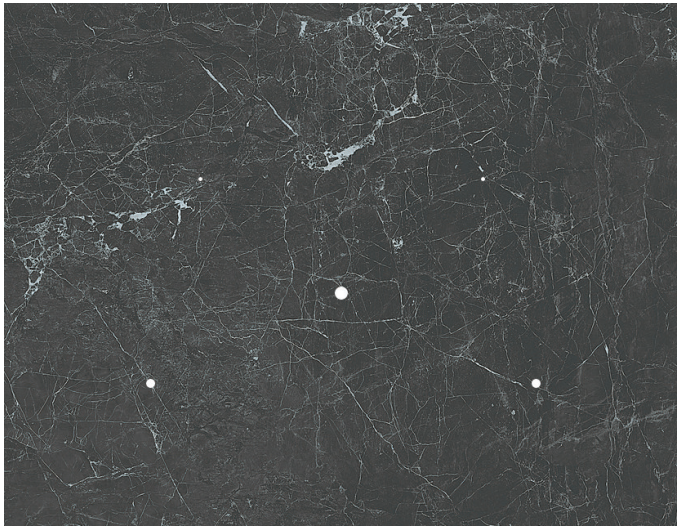


White print

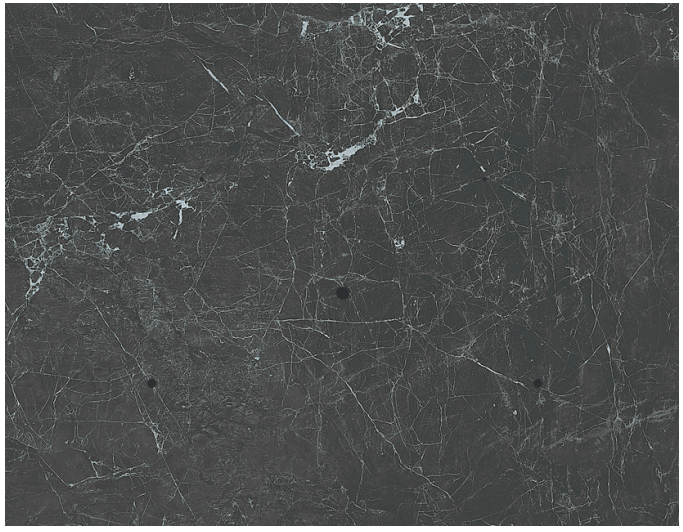


White projection

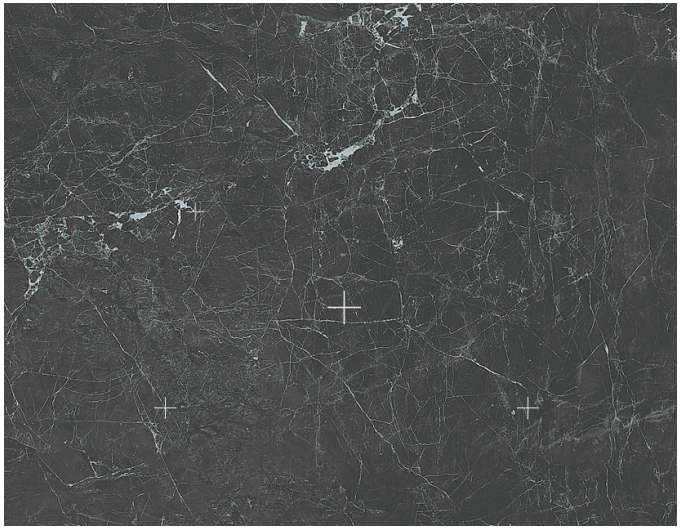
Black print



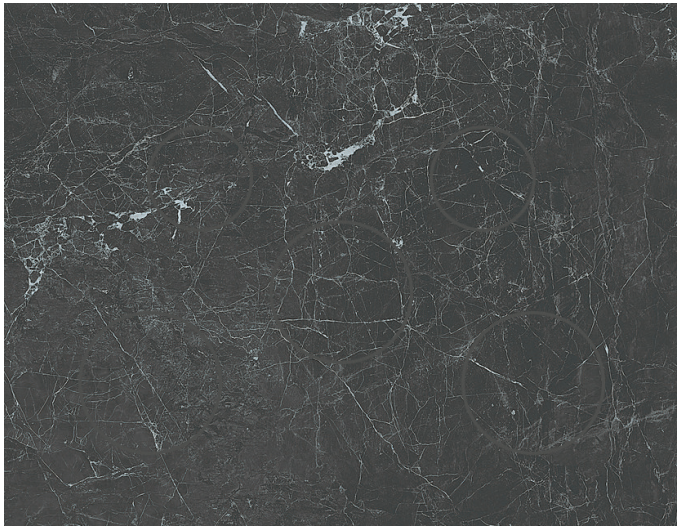
White dots print



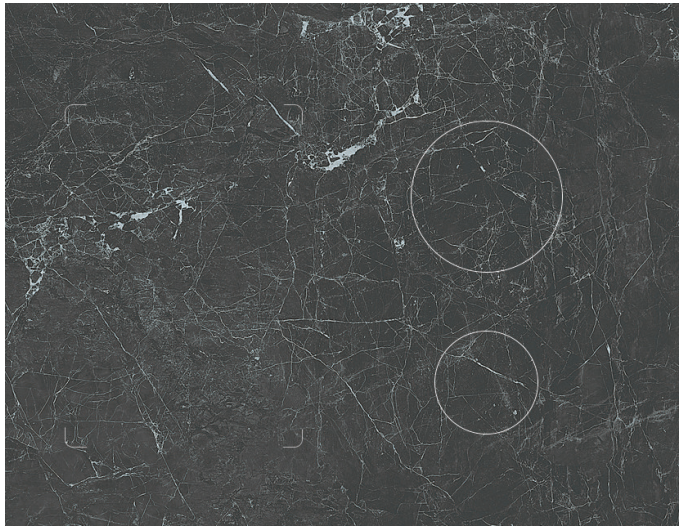
Black dots print



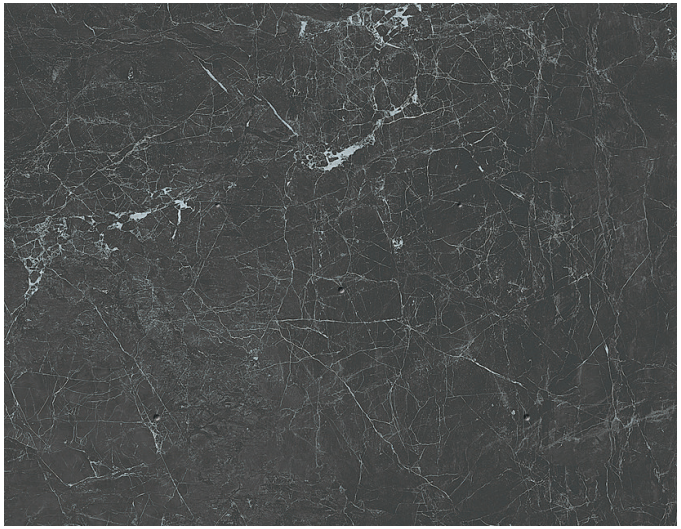
White + marks



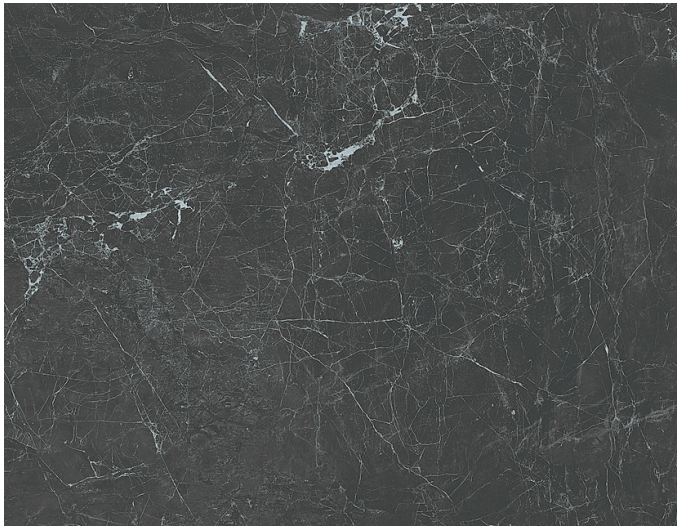
Same colour rings



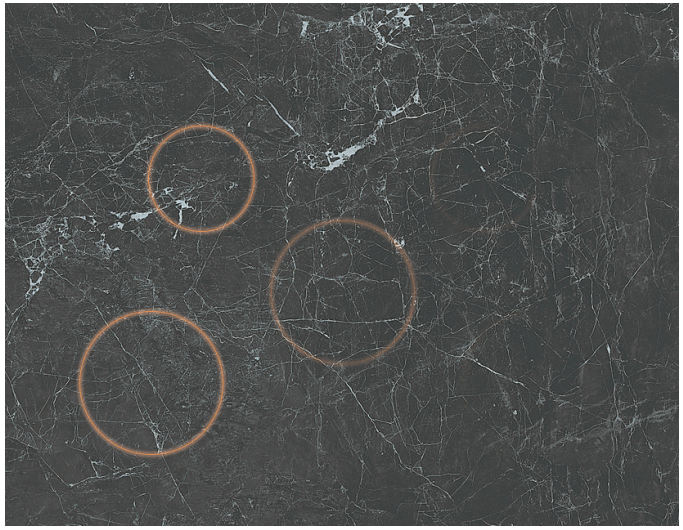
Print with flex zone



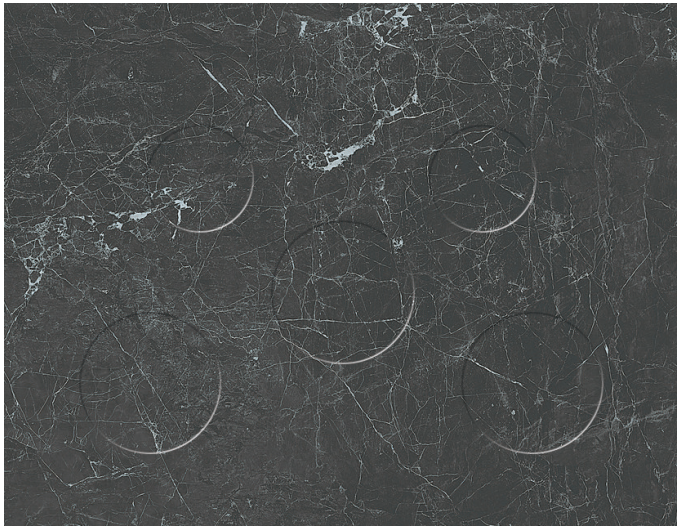
Embossed dots



Nothing

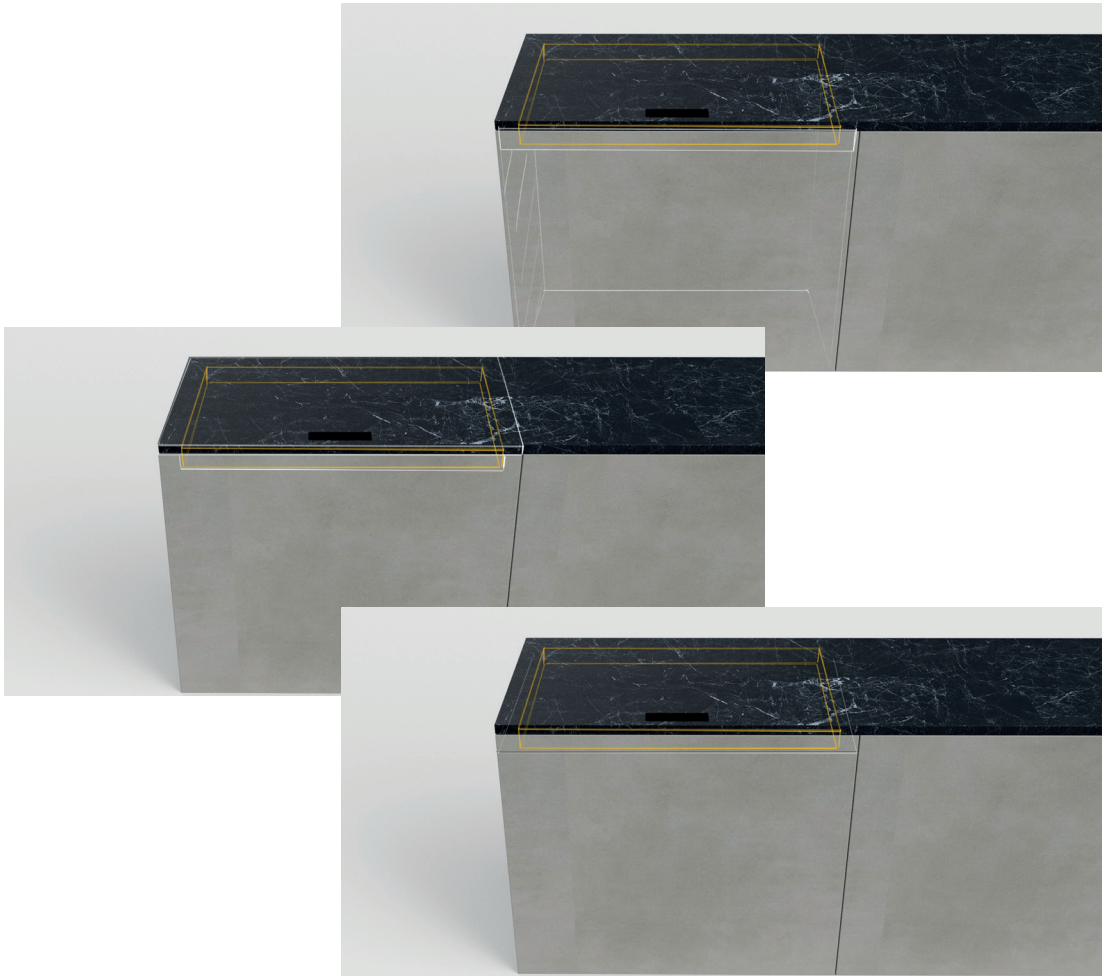


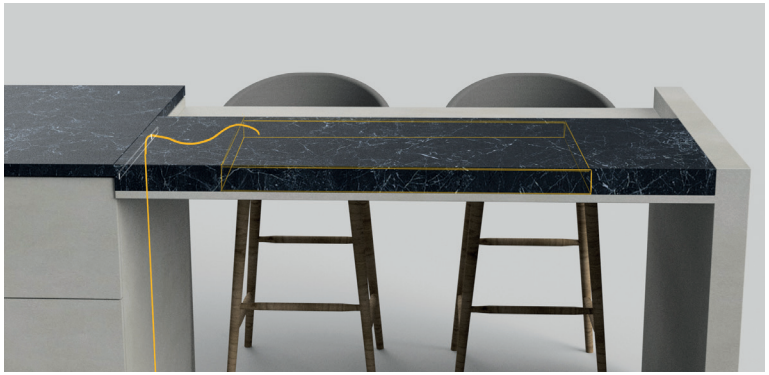
Thermochromic coating circles



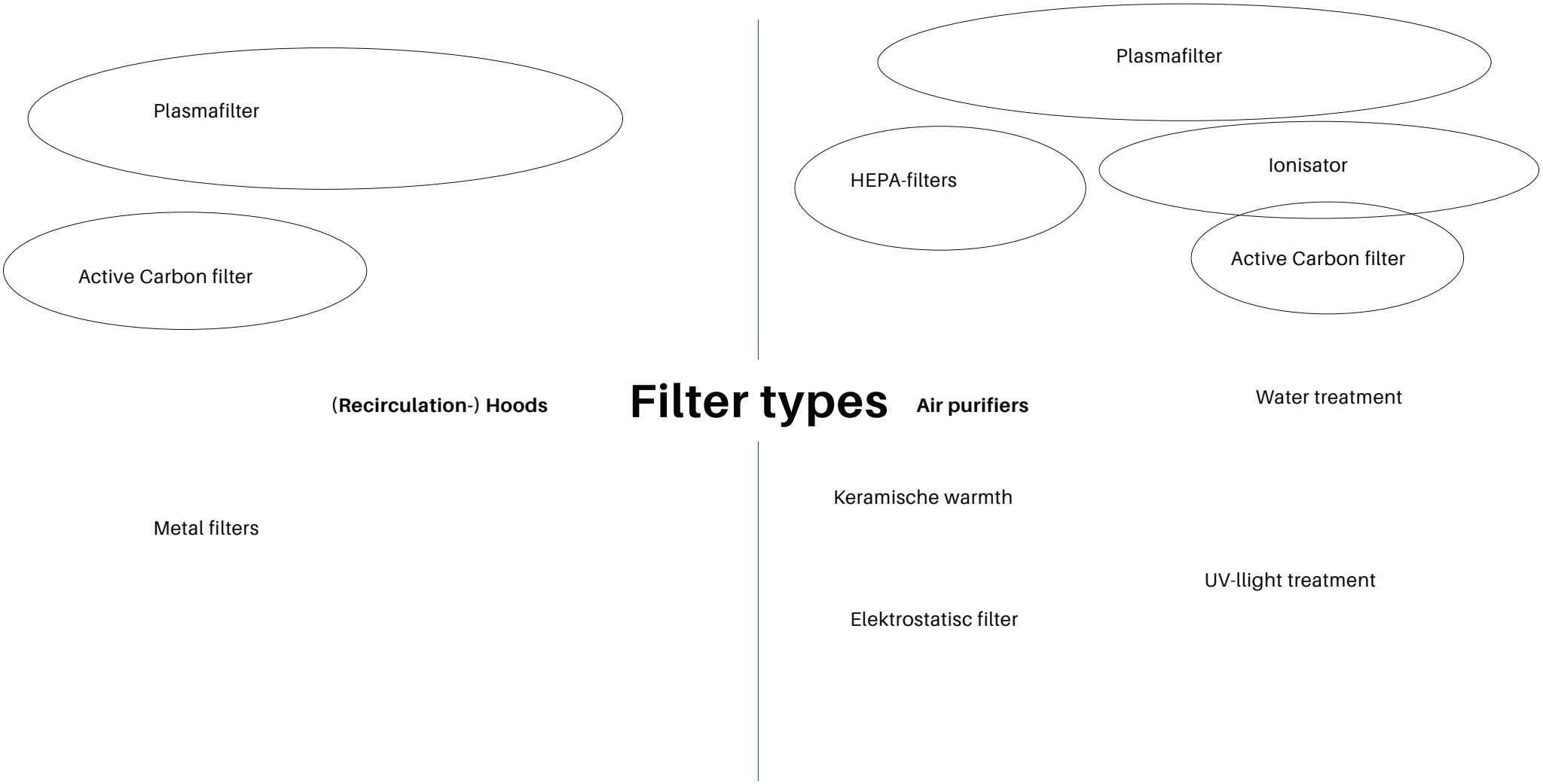
Embossed circles

APPENDIX M: IDEATION INSTALLATION INDUCTION ZONES





To compare the differences between extractor hoods and air purifiers the types of filters that are used are compared below. Promising filters that are either already in both or easy to implement in an air extractor are highlighted.



An interresting finding to make an extractor hood recircular is the recirculation filter of Plasma-Made of which some details can be seen below.

WERKINGSPRINCIPE

Na jaren van ontwikkeling is PlasmaMade sinds 2013 op de markt gekomen met een revolutionair filter systeem, speciaal gemaakt voor de afzuigkappen in de keukenbranche.
ons PlasmaMade Air filter is direct op iedere afzuigkap te plaatsen, waarbij een afvoer buis naar buiten niet meer nodig is. De voordelen hiervan zijn een directe besparing van de stook of airco kosten doordat de lucht niet naar buiten wordt afgevoerd maar in de woning blijft. Dit noemen we recirculatie, een bijkomend voordeel is dat de afzuigkap kan worden mee genomen in de EPC berekening van uw woning waardoor uw energie label eindelijk klopt.

Het PlasmaMade Air filter elimineert niet alleen de kookgeur maar ook de pollen en bacteriën in uw woning, echter niet de kookdamp, deze wordt teruggegeven aan de ruimte.
Het PlasmaMade Air filter maakt hiervoor gebruik van een 4-tal technieken.
Als eerste het plasma deel welke O2 moleculen om zet naar O3 moleculen, welke geur delen elimineert.
Ten tweede onze elektrostatische buiten kernen waarin wij onze ionen creëren door de kooklucht die er door gaat, ook wel Ion of ionen genoemd.
En ten derde onze elektrostaten met de glasfiber kern waarbij wij in staat zijn grove vervuiling en vet op te slaan en langzaam te elimineren door middel van de elektroden in de vorm van een stalen binnen en buiten raster.
Als laatste de koolstof buiten kern welke de lucht totaal reinigt en reststoffen afvangt, waardoor ons filter grove en zeer fijne verontreiniging totaal elimineert.

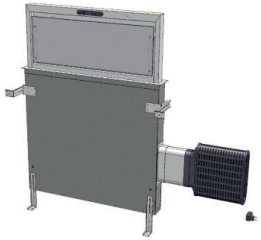
CERTIFICERINGEN

Getest op veiligheid
Het PlasmaMade filter is getest op alle mogelijke manieren om de werking en veiligheid te garanderen

ISO 9001 geproduceerd
Het PlasmaMade luchtfilter wordt geassembleerd volgens de norm van ISO 9001.

Beste prijs-prestatie
Het voordeligste PlasmaMade luchtfilter in zijn klasse.

Kwaliteitswaarborg
5 jaar fabrieksgarantie op PlasmaMade luchtfilter.



INTEGRATED

TRADITIONAL

Appassionato

More functions and charging

Final concept

APPENDIX Q: NEW LIST OF REQUIREMENTS

1. The product must be suited for all types of cooking in pans.
2. The ceramic top layer must survive temperatures of 200 degrees Celsius (Pan deep frying).
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4. The system should indicate when the surface is hot after cooking and show it to the user.
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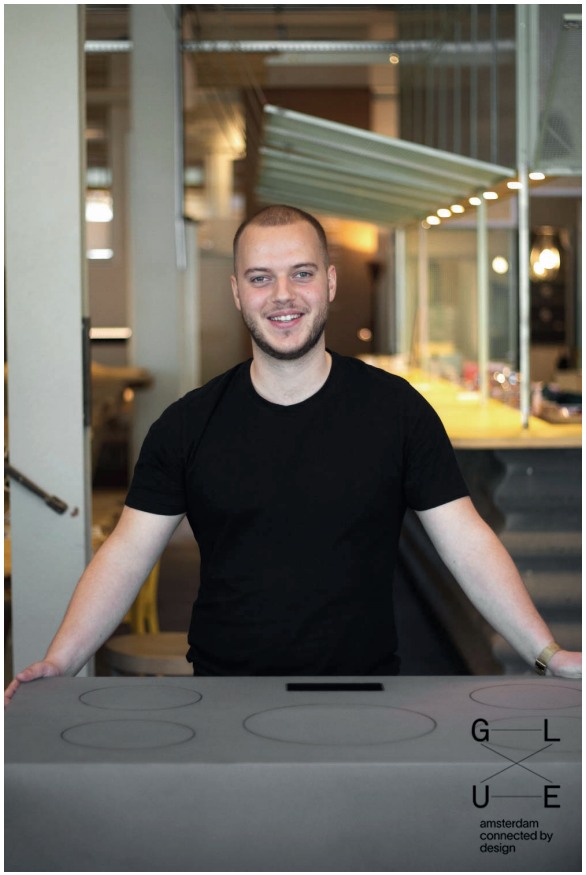
7. The combination(s) of cooking zones and flex zones must be customizable by the customer.
8. The biggest cooking zone must be able to produce 2100 Watt in normal modus and 3000 Watt in booster modus (Based on BI90MAT induction hob from Boretti)
9. The design should have four cooking zones
10. The product should meet the safety regulations of cooking on induction.
11. The surface must not scratch or get permanently dirty/colour change by being cooked on like intended.
12. The surface must be cleanable with a wet cloth.
13. A module or the whole system of induction zones must be able to be placed and removed easily (with maximum of 3 steps) for easy placement and repairability.
14. The lifespan of the product must be at least 5 years after which only certain modules have to be replaced in a worst case scenario.
15. The costumer has to be free in choice of own kitchen design (using a countertop of party collaborated with) in which the induction system and possible other options can be placed at desired location.
16. A communicating air extractor must be able to integrate/ bought.
17. A smart knob must be included to control the zones.
18. The smart knob must be able to control each different zone and show their intensities.
19. The smart knob must be able to get power at all times.
20. The surface of the countertop must show feedback when it is still hot.

To evaluate the current prototypes, Boretti was part of the GLUE Amsterdam event were they presented their current solution. To get input on both their current prototypes and my design at that time, I was there one day as well. The conclusions can be seen on the right. The next page shows some photos of the event including one of my with a prototype.

CURRENT PROTOTYPES
- Stunned by looks, mostly grey ceramic option, 1x white marble, 1x black steel
- People thought it would cost 4000,- max mostly, propably since they are young and have no experience buying a stove yet.
- Turning knobs were liked as well
- People started talking about integrated air extraction
- Worries are cleanability and safety
- Rings made it look more like “Poppenhuis”

INTEGRATED DESIGN
- Mostly preffered over stove, extra wow factor
- Choice of knobs or touch differed per person, nobody would choose smart device control. People that were more passionate about cooking would choose turning knobs. People experienced touch does not always work properly, for instance when having wet hands.
- Cooking zones were mostly preffered to only be visible during cooking, otherwise subtile marks were desired.
- Cooking functions desired in countertop were; cutting board, slow cook mode, self cleaner, japanese barbecue and air extraction
- Using the kitchen for working purposed was extremly depended on person asked whether desired or not.
- Charging your phone on induction was liked by the younger public


G L
U E
amsterdam
connected by
design

APPENDIX S: VARIATIONS COOKING ZONES

Prints
Pros:
- Cheap
- Easy to have personalised locations
- No visual representation heat

Cons:
- Always visible
- No visual representation heat

Prints + thermochromic coating
Pros:
- Cheap
- Easy to have personalised locations
- Visual representation heat

Cons:
- Always visible
- Thermochromic coating might not hold

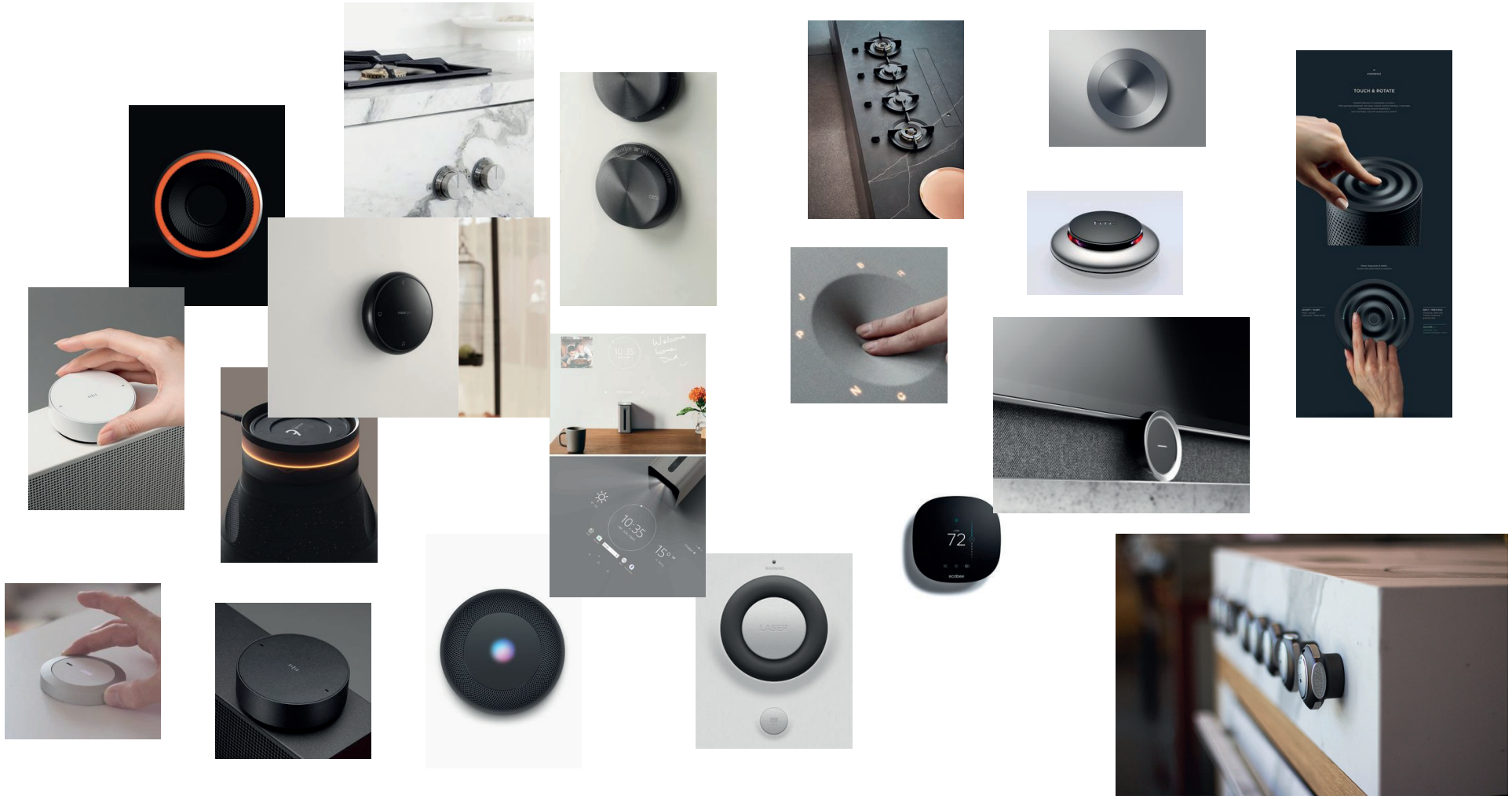
Projection
Pros:
- Doable to have personalised locations
- Visual representation heat

Cons:
- Option to be invisible when not cooking

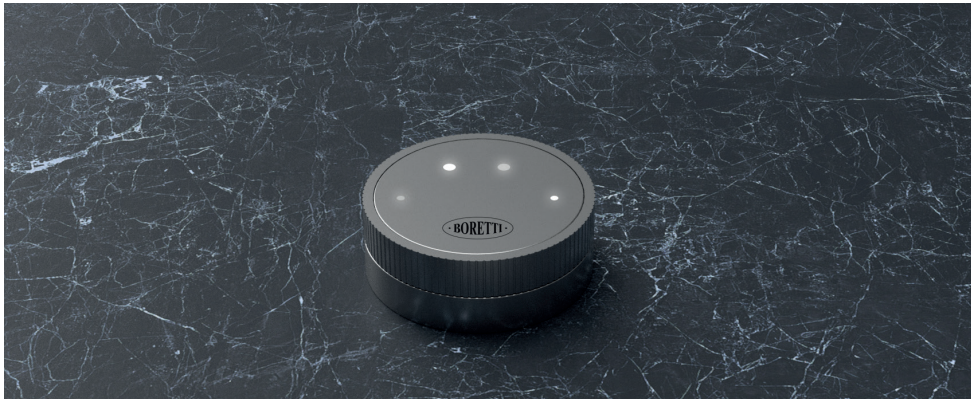
Inlay
Pros:
- Looks

Cons:
- Always visible
- Expensive
- Hard to personalise locations

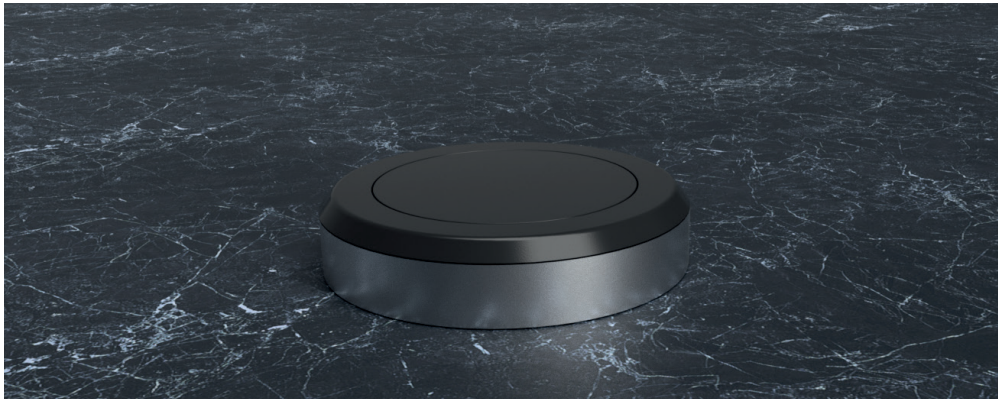
APPENDIX T: INSIPRATION BOARD KNOB DESIGN

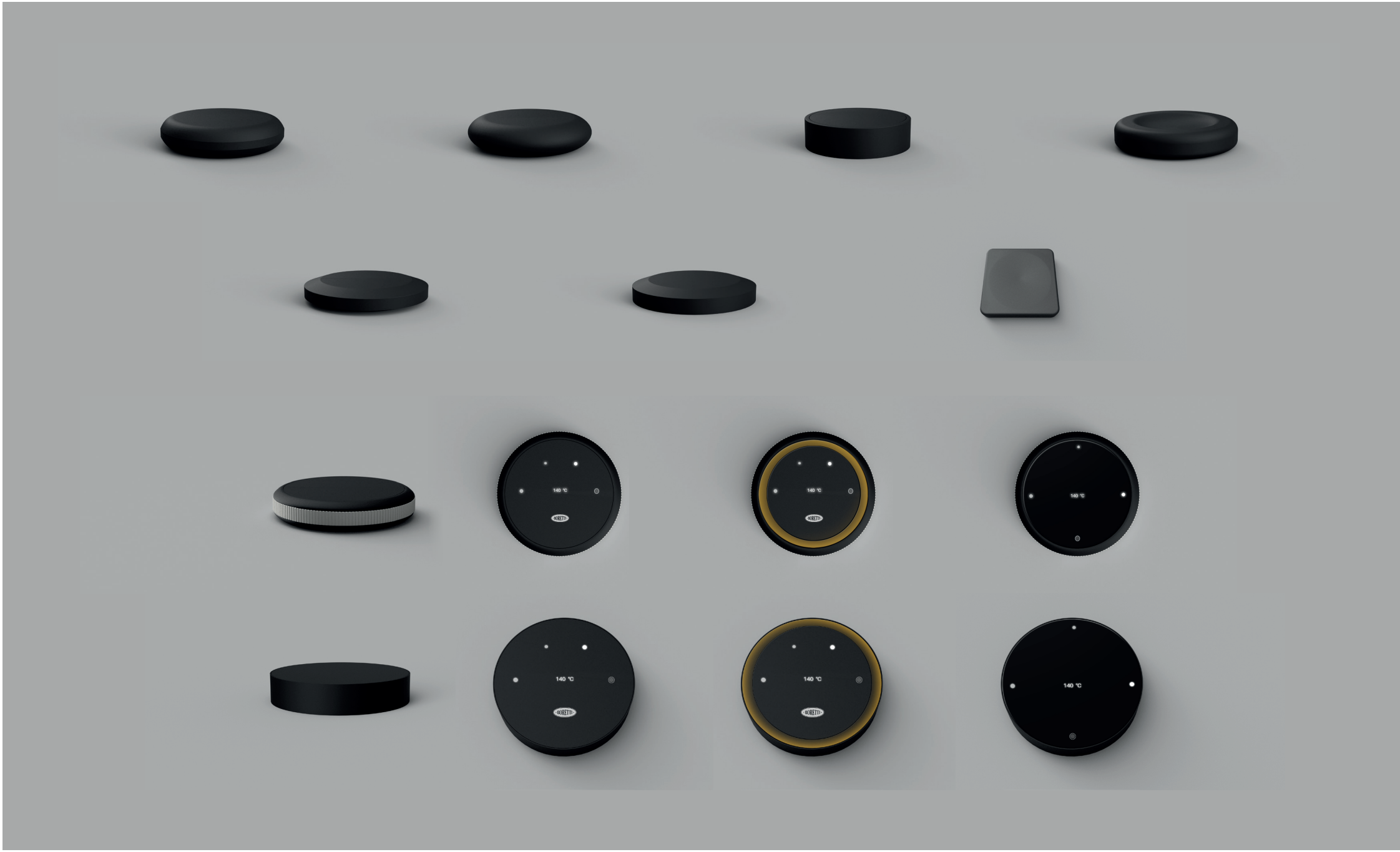


APPENDIX U: IDEATION KNOB




80 °C
BORETTI




140 °C
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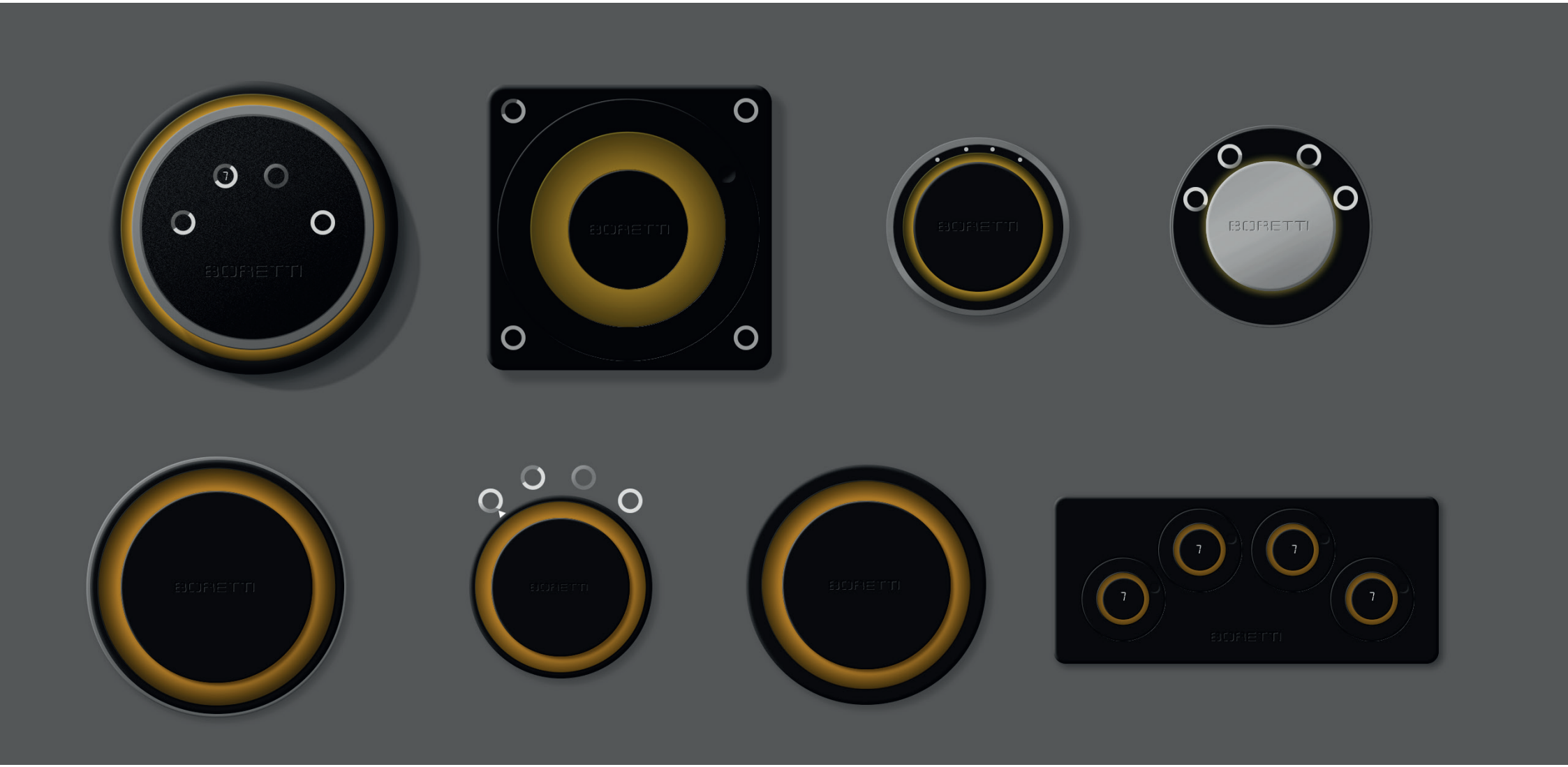
BORETTI
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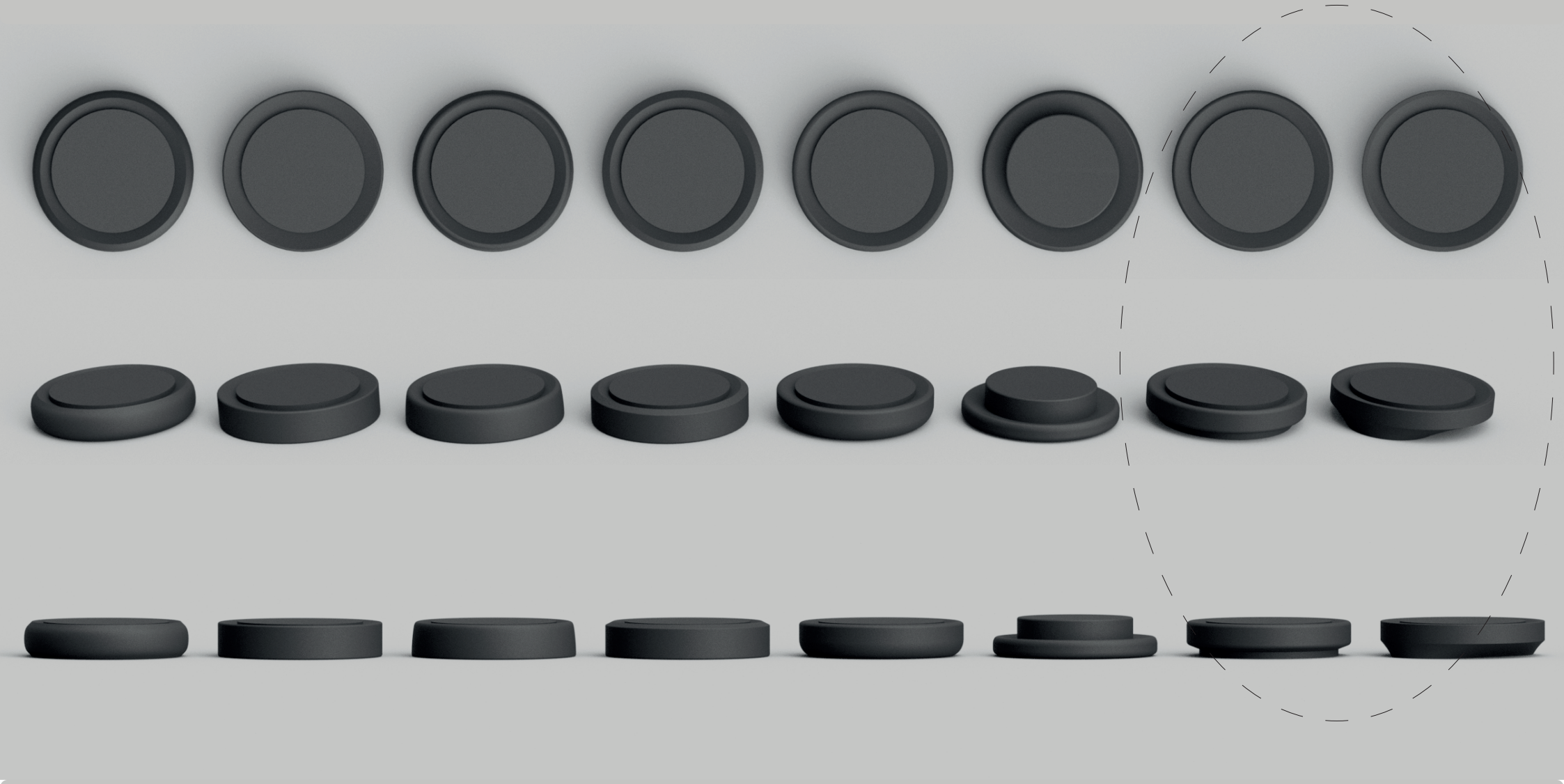
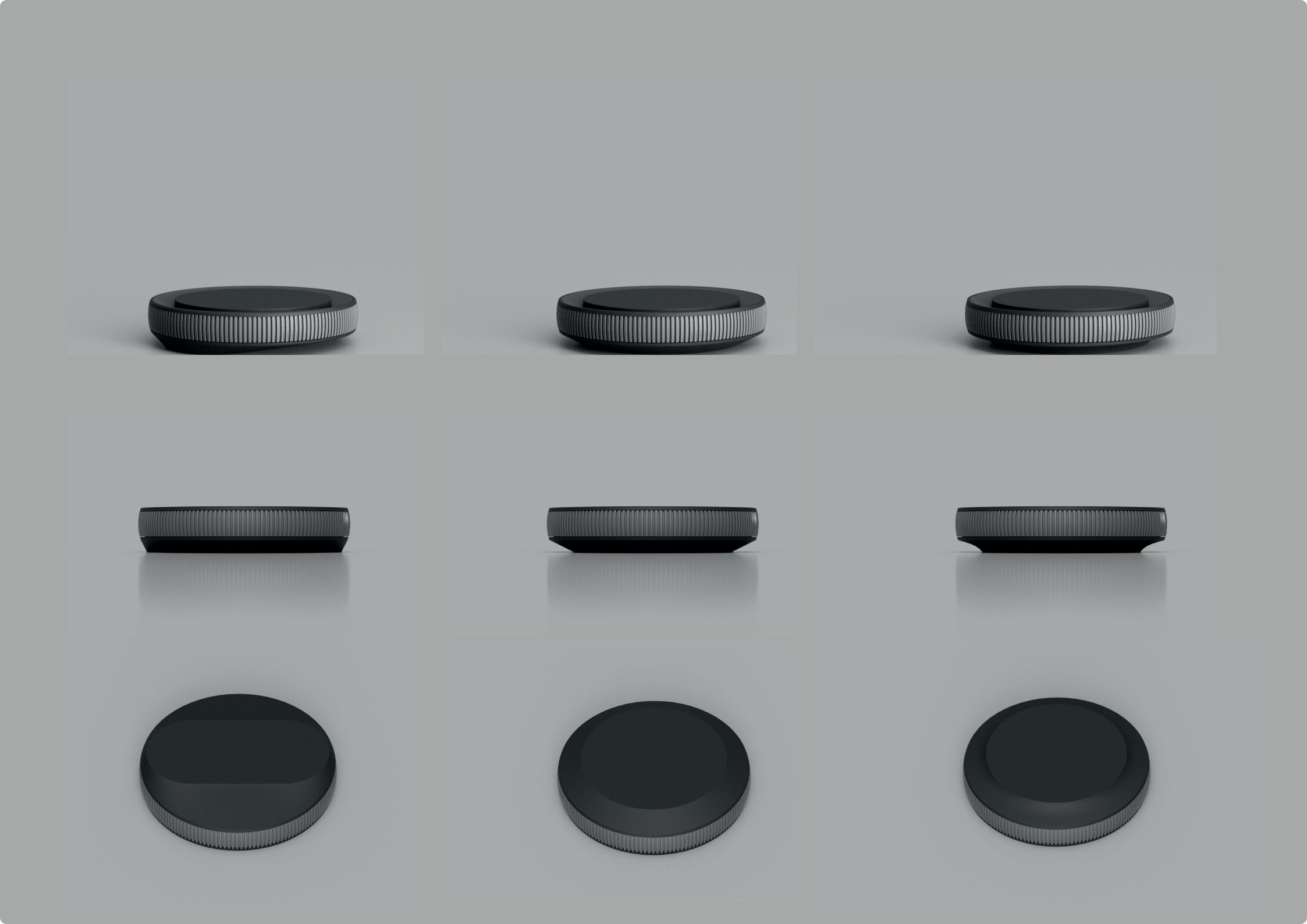
BORETTI





APPENDIX V: MATERIAL LOOK VARIATIONS KNOB


VARIATIONS INTENSITY

VARIATIONS LOGO

VARIATIONS ATMOSPHERIC EFFECT

DEFAULT/ OFF

USER PUTS INTERFACE ON LOCATION
air extractor comes up

COOKING OR AIR PURIFIER

Air purifier → Go to flow air purifier

Cooking

The user can place the interface on location

Air extractor will come up

Push and rotate button — HAPTIC FEEDBACK, TIKKING LIKE GAS

PUSH OUTER RING — TURN RING — FIRE RING PULSES

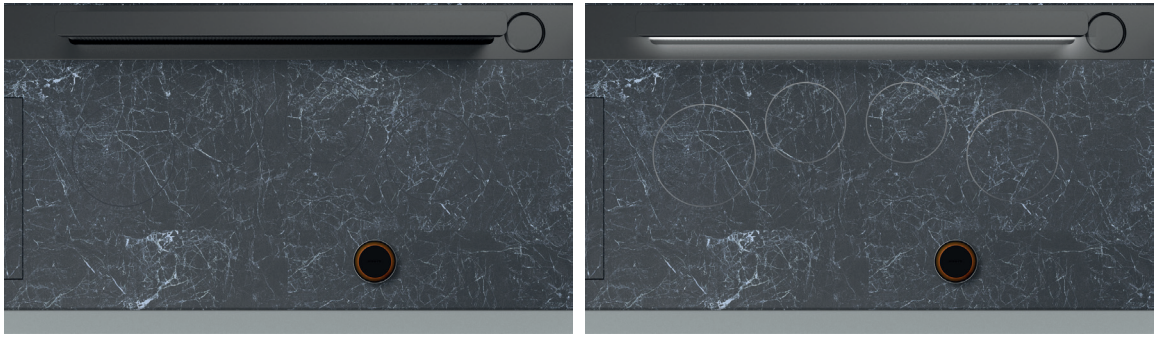
"Tikking sound and haptic feedback"

PAN DETECTED ON COOKING ZONE?

No

Show cooking zones

light shines on reflective zones



Yes

Place pan

Show on interface

Zone blinks

Read and change intensity of cooking zone

ROTATE RING

Haptic feedback per intensity higher

Ring stops turning at 0 and 9

IS THE RIGHT COOKING ZONE SELECTED

No

Select right zone

Yes

PUSH ZONE

Haptic feedback zone selected

Option to set a timer on selected zone.

FINISHED WITH COOKING?

No

Go back to “Is the right cooking zone selected?”

Yes

Turn off zones by putting the interface on “rest” location

ANY HOT ZONES LEFT?

No

Turn off whole system, air extractor goes down

Yes

TAP TIMER

ROTATE TO SET TIME

TAP AGAIN

Show hot zones

Light keeps shining on zones

"Fire" ring pulses, H in hot zones

DEFAULT/ OFF

COOKING OR LIVING

Cooking → Go to flow Cooking

Living → Press center to turn on

AIR PURIFIER OR AMBIENT LIGHT

Push light icon → Rotate ring to adjust intensity

Air purifier → Push purifier icon → Rotate ring to adjust intensity

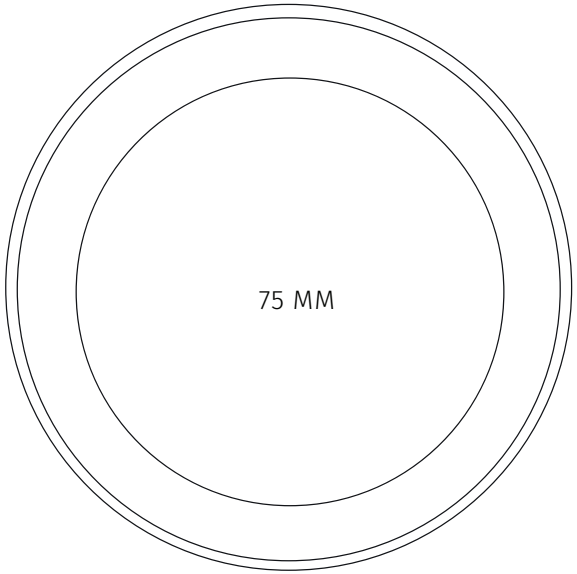
Electronics expert 1 (Jim Teunis)
With Jim I have had a chat about the connection between the control unit in the induction unit and the one in the smart knob, the wireless charging and more. The following were the conclusions:

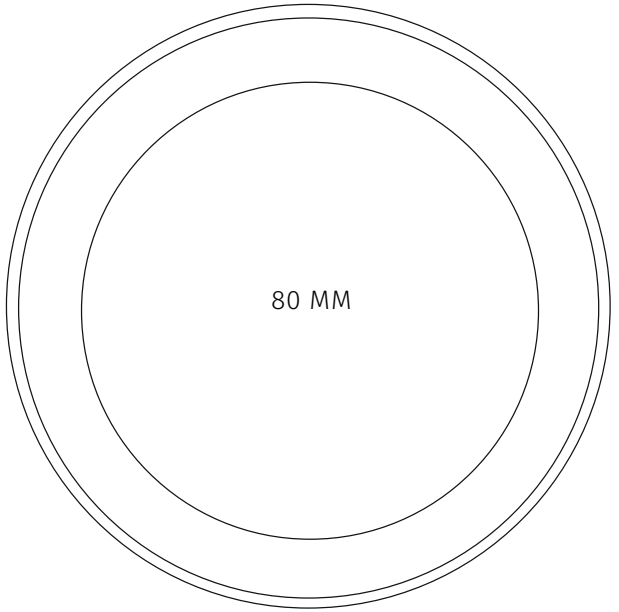
- BLE (Bluetooth low energy) is the best suited connection compared to WiFi or NFC for instance.
- In theory, charging a smart device with induction zones is possible. However, the smart device does only react properly to Qi, which is the better option to integrate.
- The smart knob could also be charged with Qi.
- The BLE can also be used easily for connecting appliances like a thermometer.

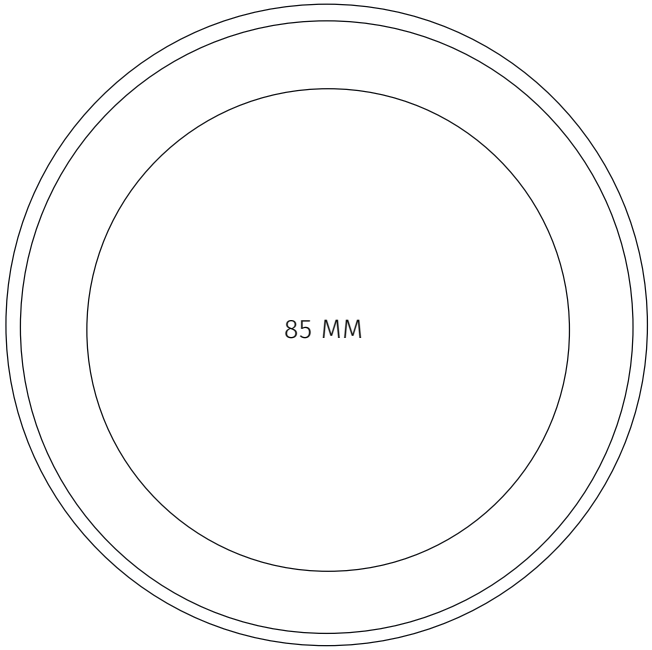
Electronics expert 2 (Martin Verwaal)
With Martin I talked about the components suitable for the knob to have the functions as desired. This, both for the actual knob and for the prototype.

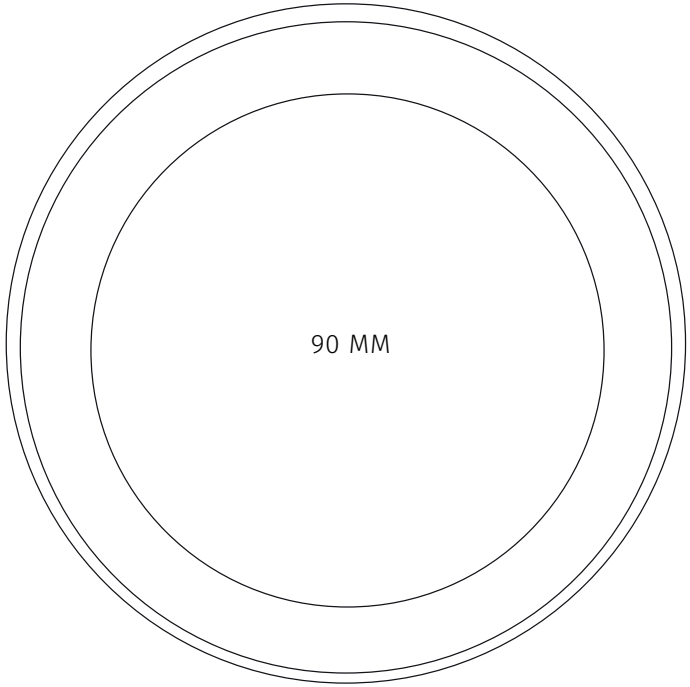
- Both the real knob and prototype can make use of a LED ring and a buzzer motor.
- To measure the rotation of the rotational ring, the real product could use a magnetic encoder. The prototype could use an IR sensor or a rotary encoder.

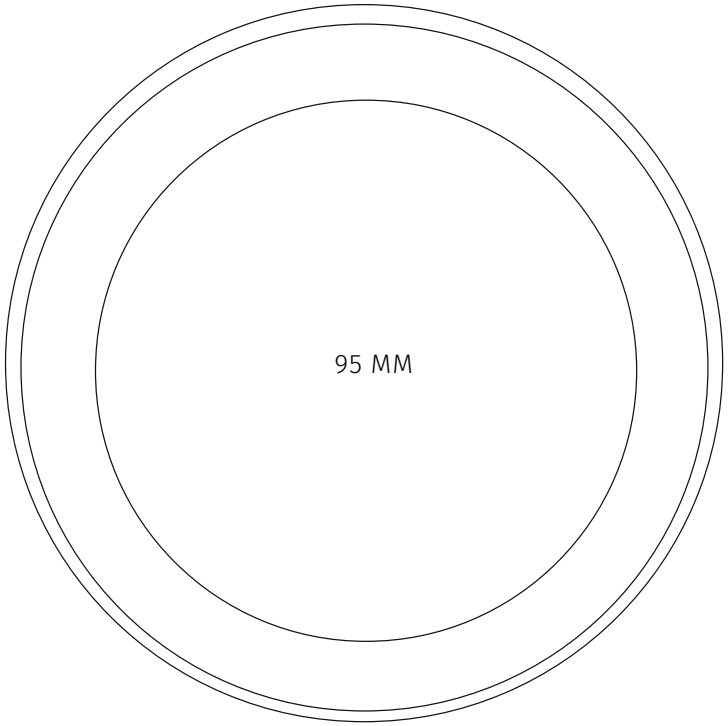
UX designer (Dario Sanchez)
With Dario I had a talk about the user interface. The most important conclusion was the use of a flowchart could help with thinking out this user experience which I did and really helped.


75 MM


80 MM


85 MM


90 MM


95 MM

QUICK PROTOTYPE

ARDUINO CODE VERSION 1

```
// NeoPixel Ring simple sketch (c) 2013 Shae Erisson
// Released under the GPLv3 license to match the rest of the
// Adafruit NeoPixel library

#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
 #include <avr/power.h> // Required for 16 MHz Adafruit Trinket
#endif

// Which pin on the Arduino is connected to the NeoPixels?
#define PIN        5 // On Trinket or Gemma, suggest changing this
to 1

// How many NeoPixels are attached to the Arduino?
int  ger= 24; // Popular NeoPixel ring size

// When setting up the NeoPixel library, we tell it how many
pixels,
// and which pin to use to send signals. Note that for older
NeoPixel
// strips you might need to change the third parameter -- see the
// strandtest example for more information on possible values.
Adafruit_NeoPixel pixels(24, PIN, NEO_GRB + NEO_KHZ800);

#define DELAYVAL 2 // Time (in milliseconds) to pause between
pixels
int val;
int encoder0PinA = 3;
int encoder0PinB = 4;
int encoder0Pos = -1;
float intensit = 0;
int intensity = -1;
int encoder0PinALast = LOW;
int n = LOW;
int kleur = 0;
int Led=7;
float valuebuzz = 0;
int A = -2;
int B=-1;
int selectedzone = 1;
int intensityA = 0;
int intensityB = 0;
int intensityC = 0;
int intensityD = 0;

void setup() {
  // These lines are specifically to support the Adafruit Trinket 5V
16 MHz.
  // Any other board, you can remove this part (but no harm
leaving it):
#if defined(__AVR_ATtiny85__) && (F_CPU == 16000000)
  clock_prescale_set(clock_div_1);
#endif
  // END of Trinket-specific code.

  pixels.begin(); // INITIALIZE NeoPixel strip object (REQUIRED)
     pinMode (encoder0PinA,INPUT);
   pinMode (encoder0PinB,INPUT);
   pinMode(Led,OUTPUT);
     attachInterrupt(digitalPinToInterrupt(2), livingcooking , RIS-
ING);

   Serial.begin (600);
}

void loop() {
 // Set all pixel colors to 'off'
// The first NeoPixel in a strand is #0, second is 1, all the way up
// to the count of pixels minus one.
for(int i=0; i<ger; i++) { // For each pixel...

  // pixels.Color() takes RGB values, from 0,0,0 up to 255,255,255
  // Here we're using a moderately bright green color:
  pixels.setPixelColor(i, pixels.Color(255,kleur,0));


   n = digitalRead(encoder0PinA);
 if ((encoder0PinALast == LOW) && (n == HIGH)) {
  if (digitalRead(encoder0PinB) == LOW) {

    encoder0Pos--;
    valuebuzz=200;
    digitalWrite(Led,HIGH);
    delay(50);
    valuebuzz=0;
    digitalWrite(Led,LOW);
     A=A-2;
    B=B-2;
    intensity= intensity-1;
  } else {
    encoder0Pos++;
    valuebuzz=200;
          digitalWrite(Led,HIGH);
    delay(50);
    valuebuzz=0;
    A=A+2;
    B=B+2;
    intensity = intensity+1;
    digitalWrite(Led,LOW);
  }
```

```
  }
  encoder0PinALast = n;

  intensity = constrain(intensity,0,9);




  if(intensity > 0){
   pixels.setBrightness(5 + intensity*3);
   kleur = constrain(100+ intensity*5.0,100,150);
  }

   else{
      pixels.setBrightness(0);
   }


   pixels.show();   // Send the updated pixel colors to the hard-
ware.

      Serial.print (“Position: “);
    Serial.print (encoder0Pos);
    Serial.print (“Intensity: “);
    Serial.println(intensity);
    Serial.print(“Selected zone:”);
    Serial.println(selectedzone);
       Serial.print(intensityA);
       Serial.print(intensityB);
       Serial.print(intensityC);
       Serial.println(intensityD);
    delay(DELAYVAL); // Pause before next pass through loop
  }
}

void livingcooking(){
  if(selectedzone == 1){
    intensityA = intensity;
    intensity = intensityB;
    selectedzone = 2;
    delay(200);
  }
   else if(selectedzone == 2){
    intensityB = intensity;
    intensity = intensityC;
    selectedzone = 3;
     delay(200);
  }
   else if(selectedzone == 3){
    intensityC = intensity;
    intensity = intensityD;
    selectedzone = 4;
     delay(200);
  }
   else if(selectedzone == 4){
    intensityD = intensity;
    intensity = intensityA;
    selectedzone = 1;
     delay(200);
  }
  }
```

ARDUINO CODE VERSION 2

```
// NeoPixel Ring simple sketch (c) 2013 Shae Erisson
// Released under the GPLv3 license to match the rest of the
// Adafruit NeoPixel library

#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
 #include <avr/power.h> // Required for 16 MHz Adafruit Trinket
#endif

// Which pin on the Arduino is connected to the NeoPixels?
#define PIN        5 // On Trinket or Gemma, suggest changing this
to 1

// How many NeoPixels are attached to the Arduino?
int  ger= 2; // Popular NeoPixel ring size

// When setting up the NeoPixel library, we tell it how many
pixels,
// and which pin to use to send signals. Note that for older
NeoPixel
// strips you might need to change the third parameter -- see the
// strandtest example for more information on possible values.
Adafruit_NeoPixel pixels(24, PIN, NEO_GRB + NEO_KHZ800);

#define DELAYVAL 2 // Time (in milliseconds) to pause between
pixels
int val;
int encoder0PinA = 3;
int encoder0PinB = 4;
int encoder0Pos = -1;
float intensit = 0;
int intensity = -1;
int encoder0PinALast = LOW;
int n = LOW;
int kleur = 0;
int Led=7;
float valuebuzz = 0;
int A = -2;
int B=-1;
int selectedzone = 1;
int intensityA = 0;
int intensityB = 0;
int intensityC = 0;
int intensityD = 0;

void setup() {
  // These lines are specifically to support the Adafruit Trinket
5V 16 MHz.
  // Any other board, you can remove this part (but no harm
leaving it):
#if defined(__AVR_ATtiny85__) && (F_CPU == 16000000)
  clock_prescale_set(clock_div_1);
#endif
  // END of Trinket-specific code.

  pixels.begin(); // INITIALIZE NeoPixel strip object (REQUIRED)
     pinMode (encoder0PinA,INPUT);
    pinMode (encoder0PinB,INPUT);
    pinMode(Led,OUTPUT);
     attachInterrupt(digitalPinToInterrupt(2), livingcooking ,
RISING);

   Serial.begin (600);
}

void loop() {
 // Set all pixel colors to 'off'
  // The first NeoPixel in a strand is #0, second is 1, all the
way up
  // to the count of pixels minus one.
  for(int i=0; i<ger; i++) { // For each pixel...

    // pixels.Color() takes RGB values, from 0,0,0 up to
255,255,255
    // Here we're using a moderately bright green color:
    pixels.setPixelColor(i, pixels.Color(255,kleur,0));

for(int j=ger; j<24; j++) { // For each pixel...

    // pixels.Color() takes RGB values, from 0,0,0 up to
255,255,255
    // Here we're using a moderately bright green color:
    pixels.setPixelColor(j, pixels.Color(0,0,0));}


     n = digitalRead(encoder0PinA);
   if ((encoder0PinALast == LOW) && (n == HIGH)) {
    if (digitalRead(encoder0PinB) == LOW) {

      encoder0Pos--;
      valuebuzz=200;
      digitalWrite(Led,HIGH);
      delay(50);
      valuebuzz=0;
      digitalWrite(Led,LOW);
       A=A-2;
      B=B-2;
      intensity= intensity-1;
    } else {
      encoder0Pos++;
      valuebuzz=200;
```

```
          digitalWrite(Led,HIGH);
      delay(50);
      valuebuzz=0;
      A=A+2;
      B=B+2;
      intensity = intensity+1;
      digitalWrite(Led,LOW);
    }

  }
  encoder0PinALast = n;

  intensity = constrain(intensity,0,9);
  if (intensity==0){ger=1;}
  else if (intensity==1){ger =1+ intensity;}
  else{ ger = intensity*2;}




  if(intensity > 0){
   pixels.setBrightness(5 + intensity*3);
   kleur = constrain(50+ intensity*6.0,50,150);
  }

   else{
      pixels.setBrightness(0);
   }



   pixels.show();   // Send the updated pixel colors to the hard-
ware.
```

```
     Serial.print ("Position: ");
    Serial.print (encoder0Pos);
    Serial.print ("Intensity: ");
    Serial.println(intensity);
    Serial.print("Selected zone:");
    Serial.println(selectedzone);
      Serial.print(intensityA);
      Serial.print(intensityB);
      Serial.print(intensityC);
      Serial.println(intensityD);



   delay(DELAYVAL); // Pause before next pass through loop
  }}

void livingcooking(){
  if(selectedzone == 1){
    intensityA = intensity;
    intensity = intensityB;
    selectedzone = 2;
    delay(200);
  }
   else if(selectedzone == 2){
    intensityB = intensity;
    intensity = intensityC;
    selectedzone = 3;
     delay(200);
  }
   else if(selectedzone == 3){
    intensityC = intensity;
    intensity = intensityD;
    selectedzone = 4;
     delay(200);
```

```
}
 else if(selectedzone == 4){
  intensityD = intensity;
  intensity = intensityA;
  selectedzone = 1;
   delay(200);
}
}
```

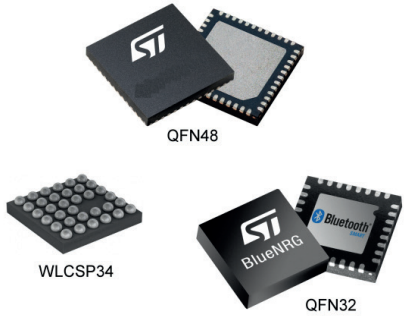
Magnetic encoder

https://www.rls.si/eng/rlc2hd-miniature-linear-and-rotary-pcb-level-incremental-magnetic-encoder

LED strip

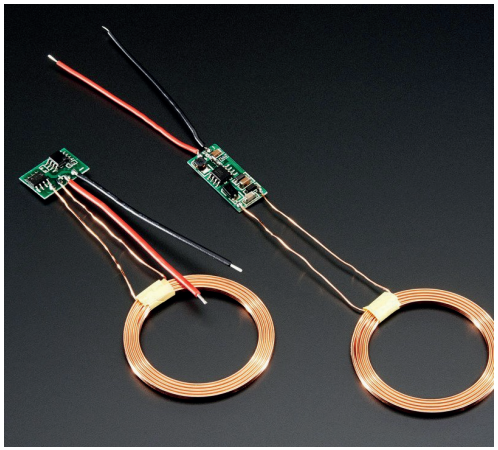
https://www.ledvance.com/professional/products/electronics-and-modules/light-engines-and-modules/linear-led-modules-for-flexible-and-individualized-lighting-solutions/led-strips-for-professional-and-industrial-applications/led-strip-superior-500/index.jsp

BLE chip

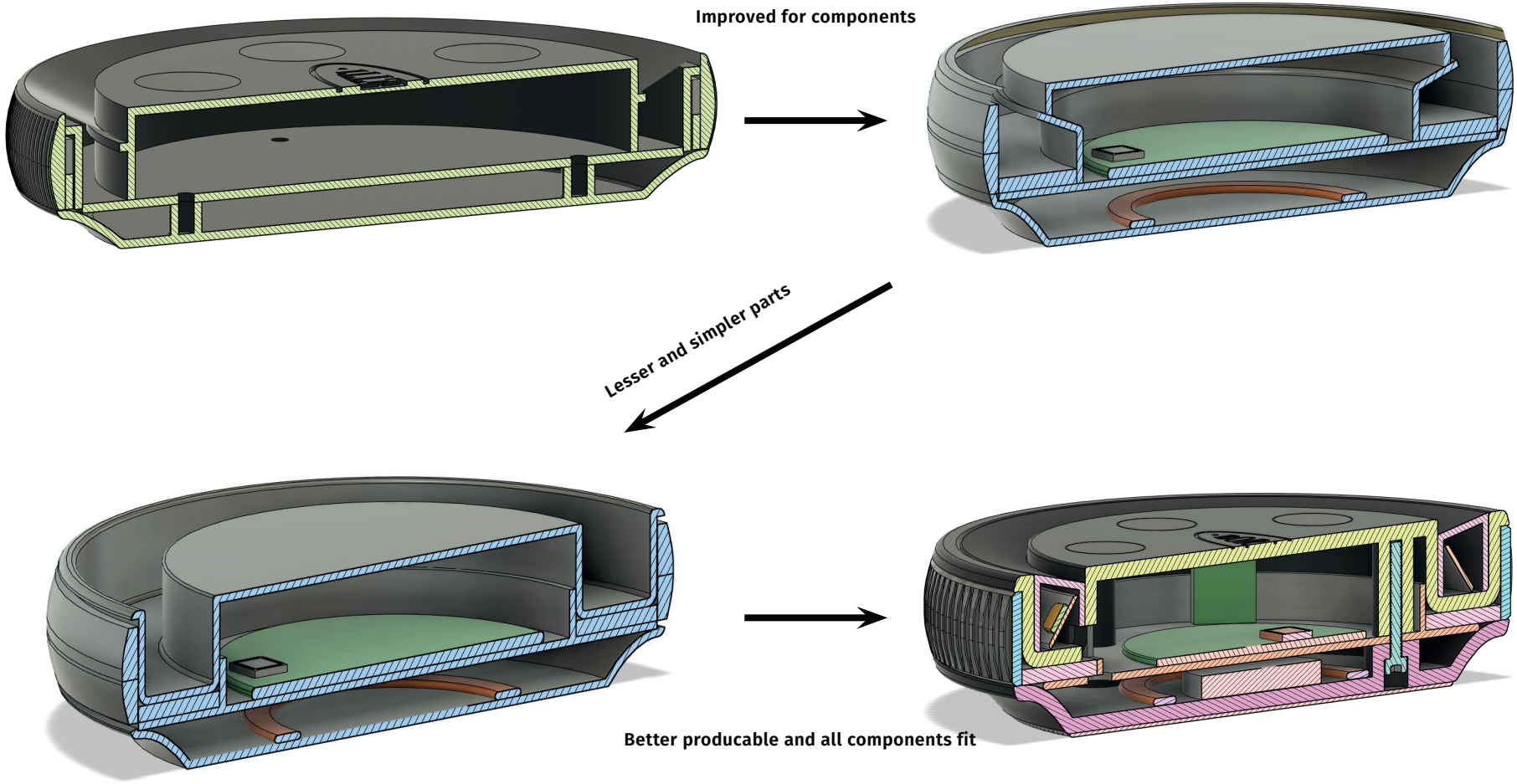


https://www.st.com/resource/en/datasheet/bluenrg-lp.pdf

Qi charging coils



https://www.adafruit.com/product/1459


Improved for components
Lesser and simpler parts
Better producable and all components fit

APPENDIX AD: EVALUATION REQUIREMENTS

1. The product must be suited for all types of cooking in pans.
   - Fulfilled enough cooking zones in different sizes are offered in the design.
2. The ceramic top layer must survive temperatures of 200 degrees Celsius (Pan deep frying).
   - Depending on the producer of the ceramic slab this is solved, the current producers Boretti considers seem to have tackled the cracking problem. The BLE makes it possible to have a thermometer connected and have a stable temperature in a pan.
3. The induction system should automatically be turned off when the temperature is getting to high (e.g. when dry cooking).
   - This just has to be programmed in the control unit.
4. The system should indicate when the surface is hot after cooking and show it to the user.
   - The knob shows a H when the surface is still hot, the light ring pulses and in the case of an integrated air extractor being bought, this shines light on the zones as long as they are hot.
5. The system has to be able to detect the presence of a pan.
   - Current technologies can be used to do this.
6. The intensity of the cooking zones must be visible during cooking.
   - Classic 0 - 9 is shown per zone, the selected zone is also represented by the intensity of the LED ring.
7. The combination(s) of cooking zones and flex zones must be customizable by the customer.
   - This is solved by creating a whole collection around the concept were consumers can choose different options.
8. The biggest cooking zone must be able to produce 2100 Watt in normal modus and 3000 Watt in booster modus (Based on BI90MAT induction hob from Boretti)
   - When the right producers is selected, this is possible.
9. The design should have four cooking zones
   - The worked out design has four cooking zones.
10. The product should meet the safety regulations of cooking on induction.
    - Pan detection can be integrated easily, it is shown when the cooking zones are still hot and other safety regulations can be easily implemented.
11. The surface must not scratch or get permanently dirty/colour change by being cooked on like intended.
    - This is true for the current considerable producers.
12. The surface must be cleanable with a wet cloth.
    - This is true for the current considerable producers.

13. A module or the whole system of induction zones must be able to be placed and removed easily (with maximum of 3 steps) for easy placement and repairability.
    - The whole induction unit should be able to install at once, this again depends on the chosen producers.
14. The lifespan of the product must be at least 5 years after which only certain modules have to be replaced in a worst case scenario.
    - The smart knob is strong, stiff and water tight which will make sure this is true.
15. The costumer has to be free in choice of own kitchen design (using a countertop of party collaborated with) in which the induction system and possible other options can be placed at desired location.
    - This is covered in the product placement section
16. A communicating air extractor must be able to integrate/ bought.
    - This is true.
17. A smart knob must be included to control the zones.
    - This is true
18. The smart knob must be able to control each different zone and show their intensities.
    - This is true.
19. The smart knob must be able to get power at all times.
    - This is true, a charging spot is integrated in multiple locations.
20. The surface of the countertop must show feedback when it is still hot.
    - This is done by the light coming from the air extractor.

Research question
What are the optimal locations for cooking zones in a countertop if they were directly integrated? Is this different per person and dish?

Number of subjects: 2

Materials needed:
- Cooking pan
- Frying pan
- Grilling pan or similar
- Cutting board
- Knife
- Probe that represents smart knob
- Food?

Method
The test has to be done at an empty countertop something that feels similar. Each subject is asked to perform the following steps:

1. Answer the question; What is your current situation, what kind of hob do you own and how would be the configuration of the placements of every probe normally?
2. How would you initially place everything if there are no limits?
3. Act like making a pasta, cooking pasta, making sauce, grilling meat, cutting etc.
4. Do the preferred locations change while being busy?
5. Would you put the knob at different places during the process or can it be fixed?
6. Would you use the same locations for cooking something different? (Option to act out a dish the subject often cooks at home)