**To:** Professor Martin

**From:** Juan Franco, WTSN 104, Section 60, Project 4

**Date:** February 8, 2020

**Re:** Research Report Rough Draft

**Topic:** Customizability/Durability

**Design Statement:**

Design a 2-slice bread toaster that uses less energy than an average 1200W model.

**Introduction:**

The toaster has been a kitchen appliance that now just seems like the usual to have in every household. The use of toasters dates back as far as the 1890s. With every year since then trying to better this kitchen appliance. Such as allowing to toast more than just two bread at a time or even trying to toast different kinds of bread. The toaster can be seen to have different problems to when it comes to energy efficiency, though not obvious. Toasters do not actually use that much energy in a regular day, even in a year. For a toaster like ours that uses 1200W for about 12 minutes a day, it uses 240Wh a day. Looking at it yearly, the device still does not add up too much on its own. The issue can be seen though when you add up the yearly price for all the kitchen appliances in the house. For us to make such a device we have to focus on the parts many do not see, such as what the device will be made of so that it works just as well as the original and lasts just as long or more. To sell such a device we will also have to focus on how it will be designed but also what other implications will it have. Such as toasting other types of bread and also how long a person wants their bread to be toasted. We have to work upon its durability and also ways that the toaster can be customized so that it can be energy efficient.

**Customization Options:**

To make an energy efficient toaster, first it has to be known where the energy is being wasted. One of the big issues with toasters is that the slots are open on the top which leads to heat being released and then making the toaster take longer to toast the bread (Newborough, M., 1988). This can also just lead to the bread not being toasted enough. The open slots have been a standard feature for toasters for a long time, but they lead to an energy waste. Keeping the same design of such a well-known appliance helps for people to associate it to its function, but in this case that design should be changed to make the device energy efficient (Ruotolo, F., 2020).

The question that gets brought up with this solution is what would cover the slots so that the heat does not leave the toaster. One solution would be to just use the same material that the exterior of the toaster is made of. Another solution could be using “energy efficient glass”(Graiz, E., 2019). This type of glass was used for office buildings so that it would not gain heat from the outside or lose heat from inside. In this study it showed positive results with the use of the glass. This would help with regulating the heat that the toaster produces to toast the bread. It would keep the heat from leaving the toaster so no energy is lost in toasting the bread. The cover would also take care of another issue. With open slots, not only will heat escape, but also cool air will enter the slots. Covering the slots will help to toast the bread without losing energy.

Another question that could arise is what if the bread is at a different temperature than room temperature, such as if it was frozen. The toaster can be customized to have a timer. A timer allows people to adjust the doneness of their toast, and there are many intuitive designs we could implement.

We could also install different settings that can be changed with buttons, such as a cancel, defrost, and reheat functions. This is so that no matter what temperature the bread maybe at, the buyer has the option to toast it as long as they want. This also helps for those mornings when someone is in a hurry to make toast.

The issue of the slots being open and the time for the bread toasting can be solved with these solutions, but another big energy waste is left. Even if the toaster is made to toast two bread slices at a time, it does not mean someone would not just use it for one slice. So while you are only using one slot, the other slot is just wasting energy. To fix this issue, the toaster would have to be able to tell when a slot is empty. Then knowing that it is empty it, that slot would not turn on.

That issue could also be solved with the toaster allowing for each slot to be controlled separately. This would allow one to toast just in one slot and not waste any energy in the second one while not being used. If someone decides to toast one at a time it would also save more energy. The toaster would still have the same regular features, just that it would have some of the same buttons for the second slot so it does not stray from what a toaster originally looks like (Ruotolo, F., 2020).

Another approach to make sure that the heat is focused on the bread, the distance from the “heater-to-bread separation of about 10 mm was deduced to be the optimal arrangement”(Newborough, M., 1988). This is so that it goes across the surface of the bread equally. That was for the original toasters though. For an energy efficient toaster, the basic requirement would be less than 10 mm separation between the heater and the bread (Newborough, M., 1988).

We want the device to be easy to use and to clean. A big issue with toasters is that toasting the bread can leave a lot of bread crumbs in the slots making it harder to keep it clean and maintain it. The extra bread crumbs can also lead to fire hazards. To resolve these issues it would be best to have a slide out crumb tray near the bottom of the toaster. This will allow it be to easier to keep the toaster clean and allow it to last longer.

**Durability:**

To make sure that the toaster is energy efficient and still friendly towards the environment, some of the usual materials used have to be checked and maybe changed. The exterior of the toaster is normally made out of plastic (Thwaites, T., 2011, pp.102). The type of plastic that tends to be used in appliances is polypropylene (Thwaites, T., 2011, pp.102). The issue with using this as an exterior is that plastic is not an environment friendly material. Plastic is produced with petroleum which releases gases into the atmosphere which contributes to global climate change. Another issue with plastic is that it fills the world’s ocean, which is causing damage to the life within it. Plastic may last a long time, but if we want a friendlier environment, another material must be used.

A material that can be used that would be durable and environment friendly would be stainless steel. Specifically, the stainless-steel grade 316LN which has shown to be highly resistant to corrosion (Fahim, A., 2019). Stainless steel is also environment friendly as it is not coated with any toxic material so it does not produce toxic run-off. This makes stainless steel 316LN the perfect replacement for the plastic exterior.

Another issue with a material used in toasters is the heating element that is uses. Nichrome wire is the heating element used by toasters. The nichrome wire does a fine job with heating, but the issue lies in the byproduct of manufacturing it. The byproduct is a toxic substance called hexavalent chromium (Suchi Dave, N. B., 2018). There are complications to eliminating this material because it does a better job than copper when it comes to releasing heat as nichrome does not conduct electricity as well as copper making it heat up faster. To fix this problem, consortium-SN6 can be used to reduce the toxic hexavalent chromium (Suchi, Dave, N. B., 2018). It reduces Cr(VI) to Cr(III) under the circumstances of “favorable condition i.e. pH 8.0, temperature 35[degrees]C, 10% inoculum size and Cr(VI) concentration 3mM”(Suchi Dave, N. B., 2018). This will allow us to continue to use the nichrome wire as it is very useful at its job compared to other materials.

A material that will to continue to be used in the toaster would be the mica. Mica is “the silver-grey sheet…that the wire heating element is wrapped around”(Thwaites, T., 2011, pp.90). It is a naturally occurring mineral that is fire proof and good insulator for heat and electricity. “These properties make it an ideal material to support wire made very hot by electricity passing through it”( Thwaites, T., 2011, pp.90). Mica is a lightweight material that is also resilient as it can withstand high heat and being exposed to electricity. It is a perfect material to use in an energy efficient toaster.

The toaster will continue to function like a regular toaster to make it easily usable to anyone with prior knowledge of a toaster. The changes to it will allow it to be more durable and also give the customer options on to toast their bread. It will lead to a friendlier toaster so that we can aim at a greener future.

**Conclusion:**

These articles will allow us to view the project deeper than we originally thought. It will teach us to view where energy was being used and then also wasted. It allows us to see solutions based on real world science. Each customization had its benefit and also led to making the toaster energy efficient. We will see what benefits the device already had and what parts had to be changed. The real-world science that was showed may not have been aimed at a toaster, but the practices could still be applied towards the project. The customizations will allow for better toasting of bread and also allow for an eco-friendly device.

**Recommendations:**

The knowledge I now have on the ideas of customizing and enhancing the durability of the device will help our team in finding a solution to our design statement. With the knowledge that I have acquired from my research, I would recommend that we need to close the slots when the toaster is in use and also allow for each slot to be used independent of the other. This will allow for heat not to escape while the bread is being toasted, and make sure no energy is being wasted if only one slot is being used. To make sure no energy is wasted, we also need to implement a timer. I also recommend that we use stainless steel 316LN for the exterior of the toaster as it has a high resistance towards corrosion and is also recyclable. Regardless of which previous ideas we do implement towards the toaster, we absolutely have to add a slide out crumb tray. Given brief reason, many appliances fall apart because of a lack of maintenance and cleaning. We cannot say that the customer will be focused on maintaining the toaster, the most we can do is make sure it is easy to clean so that it lasts longer.

**References**

Newborough, M., & Probert, S. (1988). Enhancing the heat-transfer performances of

conventional open-topped closed-sided toasters. *Applied Energy*, 29(1), 37-55. doi:

10.1016/0306-2619(88)90059-1

Ruotolo, F., Kalénine, S., & Bartolo, A. (2020). Activation of Manipulation and Function

Knowledge During Visual Search for Objects. *Journal of Experimental Psychology:*

*Human Perception and Performance*, 46(1), 66-90. doi: 10.1037/xhp0000696

Graiz, E., & Azhari, W. (2019). Energy Efficient Glass: A Way to Reduce Energy Consumption

in Office Building in Amman. *IEEE Access*, 7, 61218-61225. doi:

10.1109/ACCESS.2018.2884991

Thwaites, T. (2011). The Toaster Project. In T. Thwaites, *The Toaster Project* (pp. 44-133). New

York City: Princeton Architectural Press. Retrieved from https://ebookcentral.proquest.co

m/lib/binghamton/reader.action?docID=3387548&ppg=16

Suchi Dave, N. B. (2018). Biotransformation of Cr (VI) by Newly Invented Bacterial

Consortium SN6. *Journal of Pure and Applied Microbiology*, 1375-1384. Retrieved from

https://web-a-ebscohost-com.proxy.binghamton.edu/ehost/pdfviewer?vid=0&sid=07866f

73-26ef-43f8-9649-174bb400dba5%40sdc-v-sessmgr02

Fahim, A., Dean, A. E., Thomas, M. D. A., & Moffatt, E. G. (2019). Corrosion resistance of

chromium-steel and stainless-steel reinforcement in concrete. *Materials & Corrosion*,

70(2), 328-344. doi: 10.1002/maco.201709942