Overview

This following report offers a comprehensive overview and defines the scope of developing an innovative toaster. It begins with primary research collection, involving semi-structured interviews. The subsequent synthesis phase integrates insights from these interviews, identifying key trends and challenges.

Engineering considerations are paramount, covering safety, durability, and functionality analyses. Social impacts are assessed through user experience evaluations, ensuring inclusivity and usability across diverse demographics. Environmental impacts are evaluated via Life Cycle Assessments, guiding eco-friendly design choices from material selection to disposal considerations. Clear design criteria and specifications are established based on research findings, informing the iterative ideation, prototyping (I, II, III), and design refinement stages. User feedback, engineering analyses, and sustainability goals drive continuous improvements in functionality and usability.

The report concludes by outlining future directions and potential enhancements, emphasizing ongoing efforts to advance toaster design, address user needs, and promote sustainable product development practices.

Primary Research Collection

Method

Semi-structured interviews were conducted to gather insights into students' opinions regarding toasters. It's important to note that the selection of students for these interviews was based on convenience, and therefore may not fully represent the entire student population or the broader user base. (Interview questions and notes can be found in Appendix A and B, respectively)

Results

Interview Takeaways:

- Usage Frequency and Preferences: There is a range of toaster usage frequencies, from daily to once a month; Preferences include specific features like self-cleaning, de-sesame-ing, quicker toasting, and customization options.
- Toast Preferences and Issues: Preferences for toastiness levels vary; Common issues include burnt toast, uneven toasting, toast getting stuck, and smoke when toast gets stuck.
- Maintenance and Cleanliness Concerns: Participants express concerns about never seeing a toaster be maintained or cleaned, especially in communal settings.
- Desired Features and Technology: Desired features include self-cleaning, de-sesame-ing, quicker toasting, better alignment with settings, and customization options.
- Toaster Experience and Mishaps: Mishaps mentioned include burnt bagels, toaster oven fires, toast getting stuck, and people taking each other's items.

Summary

The information above provides a consolidated view of the common themes and insights regarding toaster usage, preferences, frustrations, and concerns among Brown University students.

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Method

While sitting at the Ratty Dining Hall, students were observed as they used the toaster without being approached. (Observation notes can be found in Appendix C).

Results

Takeaways from observations:

- Limited Setting Adjustments: Users generally do not adjust the toaster settings, preferring to leave them at the initial setting set by someone named Jules. This indicates a lack of customization or awareness of the available settings.
- Need for Clear Instructions: One user had to retoast their bread because they didn't adjust the settings initially. This highlights the importance of clear instructions or user-friendly controls to avoid such incidents.
- Variable User Behavior: While most users do not change settings, there are exceptions, such as one girl who did adjust the settings. This suggests that some users may have specific preferences or requirements for their toast.
- Monitoring Toasting: Users tend to stand directly in front of the toaster until their toast is done, indicating a preference for monitoring the toasting process closely rather than leaving it unattended.
- Sequential Toasting: Users toast items one at a time in a line, rather than side by side, suggesting a systematic approach to toaster usage, possibly influenced by the layout of the toaster area.
- Continuous Operation: The toasters are always running, even during non-peak hours like lunch or dinner, indicating a constant demand for toasted items throughout the day.
- Safety Concerns: Attempting to turn off the main toaster was hindered by a hot switch, highlighting a safety concern and potential inconvenience for users.

- Perceptible Smell: Users can smell the toaster when sitting nearby, even when it's not actively toasting. This could indicate potential maintenance or cleaning issues.
- Underutilized Secondary Toaster: A second toaster in the corner, despite being cleaner, newer, and better designed, is underutilized. This suggests that accessibility and convenience play a significant role in toaster usage.
- Observation of User Experience: A user who initially walked away and then circled back to wait for their toast suggests that users prioritize getting their toast done correctly, even if it means waiting longer.

Summary

These takeaways provide valuable insights into user behavior, preferences, and challenges related to toaster usage in the observed setting. They can inform design improvements, user education, and maintenance practices to enhance the overall toaster experience for users.

Primary Research Synthesis

Utilizing data collected from surveys and interviews and applying affinity mapping, key themes and insights were derived regarding toaster preferences and usage patterns among participants.

Identified Themes and Insights

1. User Preferences and Needs:

Participants expressed a desire for fast toasting times, preferably within 1-2 minutes, indicating a need for improved heating technology. Additionally, concerns about cleanliness and potential cross-contamination highlight the importance of easy-to-clean designs.

2. Usage Context and Frequency:

Toasters were primarily used for making various baked goods beyond bread, such as pizza, croissants, and waffles. Usage frequency varied from daily to monthly, influencing design considerations for reliability and performance.

3. Keywords and User Feedback:

Keywords like danger, clean, uneven toasting, speedy, and variety were frequently mentioned, reflecting user priorities and expectations. User feedback highlighted frustrations with safety, usability, and maintenance.

Design Criteria and Redesign Rationale

Based on the in-depth analysis of data streams, several clear design criteria and redesign rationales emerged:

- Speed Enhancement: Improving heating elements or technology to achieve faster toasting times, ideally within 1-2 minutes, addresses user preferences for speed.
- Cleanliness and Hygiene: Incorporating easy-to-clean designs with removable parts and stain-resistant materials addresses concerns about cleanliness and cross-contamination.
- Versatility: Designing adjustable settings or specific modes for different types of food beyond bread enhances toaster versatility.
- Safety and User-Friendliness: Implementing safety features like heat-resistant materials, automatic shut-off, and intuitive controls improves user safety and usability.
- Reliability: Ensuring durability and functionality even with varying usage frequencies, from daily to monthly, enhances overall product reliability.

The synthesis of primary research data through affinity mapping provides valuable insights into user needs, preferences, and pain points related to toasters. These insights inform clear design criteria and redesign rationales aimed at enhancing speed, cleanliness, versatility, safety, and reliability to improve overall user experience.

Engineering Considerations

To design a toaster that meets the needs of users, is safe to use, and built to suitable standards for a wide range of users, specific considerations need to be taken into account. There are organizations dedicated to creating these standards and the engineering standards for toasters include specifications for the physical product as well as its use. The following document provides a detailed view of the engineering considerations for toasters. The standards listed were identified through the following institutions and authorities:

- International Electrotechnical Commission
- Underwriters Laboratories
- OSHA

1. International Electrotechnical Commission

The International Electrotechnical Commission is the world's leading organization for the preparation and publication of international standards for all electrical, electronic and related technologies.[1]

1. Standard rated voltage cannot exceed more than 250 volts for single-phase appliances
    a. Remaining below the standard rated voltage ensures a longer operating life. Exceeding the rated voltage will cause the capacitor to degrade.[2]
2. No surface temperature requirements on toasters with a metallic enclosure
3. If toasters are under a cabinet or wall-mounted, surface temperatures can reach a max of 100 °C
    a. The above standards are in place to ensure a toaster is to ensure the safety and performance of toasters, while also mitigating potential risks associated with their use. Compliance with the standards helps minimize hazards like electric shock or fire accidents that could arise from faulty design or manufacturing processes.[3]

2. Underwriters Laboratories

UL is one of several companies approved to perform safety testing by the U.S. federal agency Occupational Safety and Health Administration (OSHA).[4]

1. If a toaster's clock operated switch incorporates a stay-on feature which is activated in the same direction as the countdown to OFF, two operations are required to engage the stay-on feature.
2. A toaster should be equipped with a short power-supply cord (or detachable power-supply cord) to reduce the risk from becoming entangled in or tripping over a longer cord. Longer detachable power-supply cords or extension cords are available and may be used if care is exercised in their use.
    a. Electrical cords are common tripping hazards in the workplace[5] and requiring the toaster to have a short cord mitigates the potential of becoming a hazard.
    b. Utilizing longer power-supply cords is an effective way to bring power to a device from a greater distance, however, proper care needs to be taken to ensure the cord does not become a fire hazard. Steps that can be taken include:[6]

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[1] *Who we are*. Homepage. (n.d.-b). https://www.iec.ch/who-we-are
[2] Harris, M. (2024, April 5). *Ceramic capacitors maximum voltage and derating*. Altium. https://resources.altium.com/p/voltage-derating-ceramic-capacitors
[3] *IEC 60335-2-9 - particular requirements for Toasters*. Electrical Safety Testing Laboratory. (2023, August 22). https://www.itcindia.org/iec-60335-2-9-particular-requirements-for-toasters/
[4] *OSHA's nationally recognized testing laboratory (NRTL) program - appropriate test standards*. Occupational Safety and Health Administration. (n.d.-a). https://www.osha.gov/nationally-recognized-testing-laboratory-program/list-standards
[5] SERVICEMASTER RESTORE. (n.d.). *Electrical Cord Safety & Hazards: Servicemaster Restore®*. Service Master Restore. https://www.servicemasterrestore.com/blog/fire-damage/common-hazards-with-electrical-cords-in-the-workplace/
[6] *Extension cord safety: What to do & what to avoid*. State Farm. (2023, August). https://www.statefarm.com/simple-insights/residence/extension-cord-safety-what-to-do-and-what-to-avoid

i. Select the right cord
    1. Cords marked specifically for outdoor use should be used outdoors
    2. Consider the length, thickness, outlet shape, and whether it can handle the amps and wattage of the device

ii. Usage
    1. Inspect the cord
    2. Don't
        a. remove an extension cord's grounding pin to fit into a two-prong outlet.
        b. power multiple appliances with one cord.
        c. use indoor extension cords outdoors.
        d. overload a power strip or plug multiple cords together.
        e. run extension cords under rugs or furniture.
        f. extension cords to floors or attach them to surfaces with staples or nails.
        g. bend or coil cords when they're in use.
        h. use extension cords with space heaters.
        i. use extension cords that feel hot to the touch.

iii. Caring for extension cords
    1. Unplug extension cords when they're not in use.
    2. Pull the plug — not the cord — when disconnecting from the outlet.
    3. Store cords indoors.
    4. Throw away damaged cords.

3. OSHA

As a government agency, the Occupational Safety and Health Administration (OSHA) sets and enforces standards for safe and healthful working conditions for workers in the private and public sectors.[7]

1. The heating elements of a toaster may be the only live parts exposed to contact.
    a. Toasters have the potential to become fire hazards due to their heating capabilities. Many units have been recalled because they turn on once they are plugged in.[8] Unexpected behavior is cause for concern as the potential for danger increases. Ensuring that the only exposed parts of a toaster are controlled is imperative for user safety.

To design a toaster that meets user needs, ensures safety, and adheres to suitable standards, thorough engineering considerations are essential. Standards set by reputable organizations like the International Electrotechnical Commission (IEC), Underwriters Laboratories (UL), and the Occupational Safety and Health Administration (OSHA) play a crucial role in guiding toaster design and manufacturing processes.

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[7] *About Osha*. Occupational Safety and Health Administration. (n.d.). https://www.osha.gov/aboutosha
[8] *Appliance fires - consumer reports*. Appliance fires - Consumer Reports. (n.d.). https://www.consumerreports.org/cro/magazine/2012/03/appliance-fires-is-your-home-safe/index.htm

The engineering requirements outlined by these institutions are not only vital for ensuring compliance but also reflect a deep understanding of the potential risks associated with toaster use. By adhering to these standards, toaster manufacturers can enhance user safety, minimize workplace hazards, and maintain product performance and longevity.

Social Impacts

In the realm of engineering design, particularly in the context of household appliances like toasters, understanding the societal impact and user interpretations of safety instructions is paramount. This section delves into the insights gleaned from relevant literature, shedding light on key considerations that influence the engineering process and product outcomes.

Augmented Robotic Toaster: Exploring Social Interactions[9]

One significant area of exploration in recent literature is the integration of social capabilities into robotic appliances, exemplified by the concept of an augmented robotic toaster. Research by Ye et al., delves into this realm, proposing the augmentation of traditional home appliances with capabilities akin to social robots. The rationale behind this approach is to enhance user experience and acceptance by infusing playful and social interactions into mundane tasks like making toast. By mimicking social robots' behaviors and allowing for personalized interactions, such designs aim to bridge the gap between technological functionality and human-centric engagement.

Expressive Toaster Design: Shifting towards User-Centric Interfaces[10]

Another notable theme in literature is the shift towards more expressive and user-centric interfaces in household appliances, as exemplified by the Expressive Toaster design concept. Alonso presents a case study exploring the mapping between user actions and toasting outcomes through tactile feedback and intuitive interfaces. The design incorporates a textured cover that allows users to set temperature and toasting duration by stroking, while also providing sensory feedback on the bread's crispiness. This approach not only enhances user engagement but also emphasizes the importance of designing for user experience and interaction beyond traditional menu-based interfaces.

Consumer Perception of Safety Instructions: Clear Communication for User Safety[11]

A critical aspect of toaster design pertains to user safety and the interpretation of safety instructions. Research conducted by Lim and Vigilante delves into consumer perceptions of common safety instructions, such as "do not leave unattended." The study reveals significant

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[9] Ye, M., Schneiders, E., Lee, W.-Y., & Jung, M. (2023). The Future of Home Appliances: A study on the robotic toaster as a domestic social robot. *2023 32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. https://doi.org/10.1109/ro-man57019.2023.10309555

[10] Alonso, M. (2016, September). (PDF) Feedforward Toaster: Design mapping for expressive use. https://www.researchgate.net/publication/308519861_Feedforward_Toaster_Design_Mapping_for_Expressive_Use

[11] Lim, R. W., & Vigilante, W. J. (2010). Consumers' interpretation of the statement: "do not leave [insert product here] unattended." *PsycEXTRA Dataset*. https://doi.org/10.1037/e578822012-004

variations in how consumers interpret such warnings, particularly concerning different types of products like battery chargers, cooking appliances, or open flames. Misunderstandings regarding safety instructions can have substantial consequences, highlighting the necessity for clear and explicit communication in product design to ensure user safety and mitigate potential hazards.

Reassessing Human Primacy in Design: Embracing Technological Evolution[12]

Furthermore, literature challenges the traditional notion of human primacy in design, especially with the advent of technologies like the Internet of Things (IoT). Cruickshank argues for a paradigm shift in design thinking, acknowledging the growing role of non-human actors and decision-making abilities in design processes. This shift necessitates reevaluating fundamental design assumptions and embracing new approaches that accommodate technological advancements and societal changes.

Affordance Features: Enhancing User-Product Interaction[13]

Lastly, the concept of affordance features in household products emerges as a critical consideration in toaster design. Kim et al. outlines three types of affordance features – Functional, Ergonomics, and Informative – that play a pivotal role in user-product interaction. By identifying and integrating these features, designers can create products that align with user expectations, enhance usability, and promote a seamless user experience.

In conclusion, integrating insights from literature on societal impact and user interpretations is essential for designing toasters that not only meet functional requirements but also resonate with user needs, preferences, and safety considerations.

Environmental Impacts

To comprehensively evaluate the potential environmental impact of our toaster design, we employed a robust methodology that integrates a circular journey map and a detailed life cycle assessment (LCA). Drawing from established methods discussed in class and supplementary reading materials, our aim was to identify, analyze, and mitigate numerous environmental issues across the toaster's entire life cycle.

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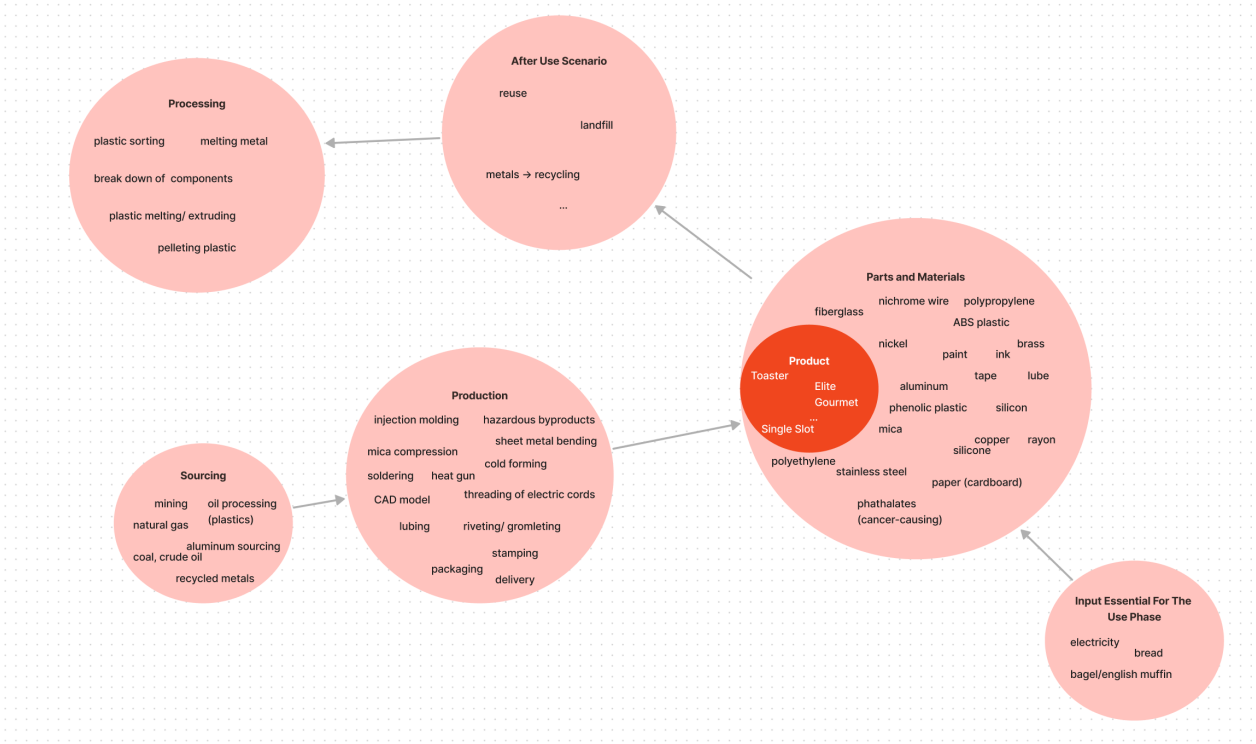
[12] Cruickshank, L., & Trivedi, N. (2017). Beyond human-centred design: Supporting a new materiality in the internet of things, or how to design when a Toaster is one of your users. *The Design Journal*, *20*(5), 561–576. https://doi.org/10.1080/14606925.2017.1349381

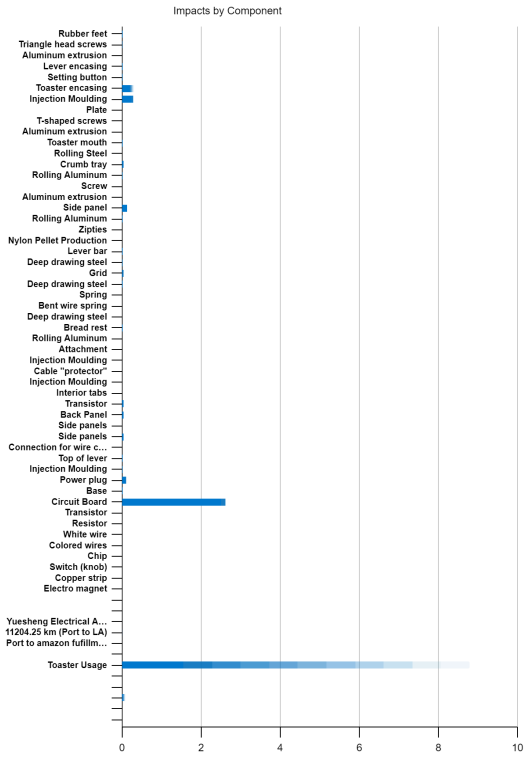
[13] Kim, Y. S., Lim, J. S., & Park, J. A. (1970, January 1). *Affordance feature reasoning: A case study for human-product interaction*. The Design Society - a worldwide community. https://www.designsociety.org/publication/28605/Affordance+Feature+Reasoning%3A+A+Case+Study+for+Human-Product+Interaction

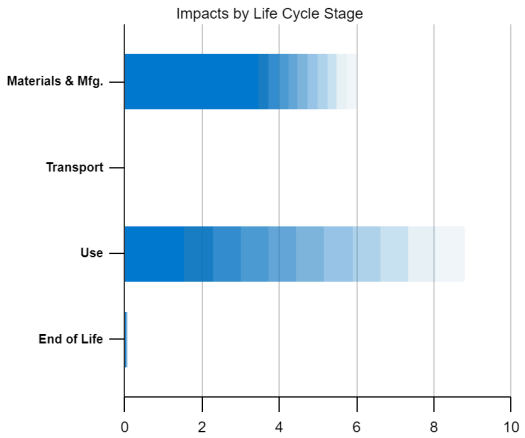


The circular journey map served as a foundational tool, providing a holistic view of the toaster's life cycle stages, including sourcing, production, use, and end-of-life considerations. During the sourcing phase, our analysis revealed critical environmental concerns related to raw material extraction. Issues such as resource depletion, habitat destruction due to mining activities, and water pollution from processing plants were identified as key challenges. Moving into the production phase, we focused on assessing energy consumption, greenhouse gas emissions, and waste generation. High-energy manufacturing processes and inefficient waste management practices can significantly contribute to the environmental footprint of a product.

One of the crucial insights derived from the circular journey map was the recognition of the use phase as a major environmental hotspot. Energy usage during the operational lifespan of the toaster emerged as a significant contributor to greenhouse gas emissions and overall environmental burden.

To complement the qualitative insights from the circular journey map, we conducted a detailed life cycle assessment (LCA) encompassing quantitative data analysis across all life cycle stages. The LCA methodology allowed us to quantify environmental impacts in terms of carbon emissions, energy consumption, water usage, and waste generation. By utilizing LCA software tools and databases, we were able to model various scenarios, assess environmental hotspots, and identify areas for improvement in our toaster design.





The LCA findings were visualized through comprehensive graphs and charts, providing a nuanced understanding of environmental impacts at each life cycle stage. Uncertainty shading was incorporated to account for data variations and modeling assumptions, ensuring robustness in our environmental impact assessment.

The results of the LCA reaffirmed the significance of the use phase in terms of environmental impact, particularly in terms of energy consumption and carbon emissions. This finding reinforced the importance of implementing energy-efficient features and promoting sustainable usage practices among toaster users.

In conclusion, our in-depth environmental impact assessment utilizing the circular journey map and LCA methodologies provided valuable insights and data-driven recommendations for designing an eco-friendly toaster. By addressing environmental challenges across the life cycle stages and integrating sustainability principles into design decisions, we aim to minimize the environmental footprint of our toaster and contribute positively to environmental stewardship in the appliance industry.

Design Criteria/ Specification

Our journey in developing a toaster has been guided by a thorough analysis of primary and secondary research data. Following this comprehensive analysis, the following design specification table was created; it encapsulates the essence of our findings and insights. This

table serves as a distilled representation of the key design criteria, prioritizing elements based on their significance and relevance derived from the data at hand.

Design Requirements	Requirement Source
Toasting time should be around 2 minutes	User Interviews
Toaster should be easy and safe to clean on the inside	User Interviews
Toaster encasing and lever should have a room temperature and be safe to touch at any point	User Interviews
Toast shouldn't pop out of the toaster and fall	User Interviews
Light & sound cues	User Interviews; Harrison, Horstman, Hsieh, Hudson (2012)
The toaster shouldn't melt/release fumes when used	Circular mapping
Easy to dismantle in order to safely clean	Circular mapping
Biodegradable plastic	Circular mapping
Toaster production should not dapple into any unethical sourcing practices	Bureau of International Labor Affairs; Schipper and Cowan
Design should be user friendly for various demographics, including children and elderly people	Grant
Should consider kinesthetic experience interaction; ie: Motions that direct toasting, resistance in a dial	Stienstra et al. (2016)
Should consider ways other than numbers to indicate toasting	Stienstra et al. (2016)
Consider the usage and heating of materials, and that materials shouldn't melt when the toaster is used	Thwaites (2011)

1. Toasting Time: The requirement for toasting time to be around 2 minutes is justified based on insights from user interviews. The primary research revealed a strong preference among users for faster toasting times, indicating that a 2-minute duration aligns with user expectations and contributes to overall satisfaction with the toaster's performance.
2. Ease of Cleaning and Safety: The specification for the toaster to be easy and safe to clean on the inside is substantiated by data gathered from user interviews. Participants emphasized the importance of hassle-free cleaning procedures and safety features, highlighting the impact of these aspects on user experience and product longevity.
3. User Safety and Convenience: The criterion stating that the toaster encasing and lever should remain at room temperature and be safe to touch at any point is justified by user feedback from interviews. Ensuring user safety and convenience during operation is crucial for preventing accidents and enhancing usability, as emphasized by the respondents.
4. Prevention of Toast Mishaps: The requirement that toast shouldn't pop out of the toaster and fall is based on observations and insights from user interviews. Users expressed frustration with toast mishaps, indicating the importance of designing mechanisms to prevent such occurrences and enhance overall user convenience.
5. Incorporation of Light & Sound Cues: The inclusion of light and sound cues as design specifications is supported by both user interviews and literature sources such as Harrison, Horstman, Hsieh, and Hudson (2012). These sensory cues are known to enhance user experience, accessibility, and engagement with the toaster, aligning with user preferences and expectations.

6. Environmental Safety: The specification that the toaster shouldn't release fumes or melt during use is derived from insights obtained through circular mapping exercises. Environmental safety considerations are paramount, and these criteria ensure that the toaster maintains ecological integrity and user health during operation.
7. Ease of Dismantling for Cleaning: The requirement for the toaster to be easy to dismantle for safe cleaning is justified by the circular mapping findings. Facilitating cleaning processes enhances hygiene, maintenance ease, and overall product durability, addressing user concerns and ensuring long-term usability.
8. Adoption of Biodegradable Materials: The specification for using biodegradable plastic is driven by environmental sustainability goals identified through circular mapping. Opting for eco-friendly materials minimizes ecological impact, aligning with responsible manufacturing practices and societal expectations.
9. Ethical Sourcing Practices: The design criterion advocating against unethical sourcing practices is supported by data from the Bureau of International Labor Affairs and research by Schipper and Cowan. Ensuring ethical business conduct and social responsibility is crucial in the design and production of the toaster.
10. Inclusive and User-Friendly Design: The requirement for the toaster to be user-friendly for various demographics, including children and elderly individuals, is justified by insights from a grant-supported study. Designing for inclusivity and accessibility enhances usability and ensures that the toaster caters to diverse user needs.
11. Kinesthetic Interaction and Alternative Indicators: Incorporating kinesthetic interaction and exploring non-numeric indicators are justified based on research by Stienstra et al. (2016). These design elements enrich user experience, offer innovative functionality, and cater to user preferences for diverse toasting experiences.
12. Material Durability and Safety During Heating: The criterion emphasizing material durability and safety during heating is derived from research by Thwaites (2011). Ensuring that materials withstand heating processes without compromising safety is essential for product longevity and user well-being.

In addition to the engineering considerations detailed above, the design requirements table details the specifications on design, as opposed to construction, that the interviews and secondary research pointed to. Below is a detailed view of the factors we prioritized when designing a toaster.

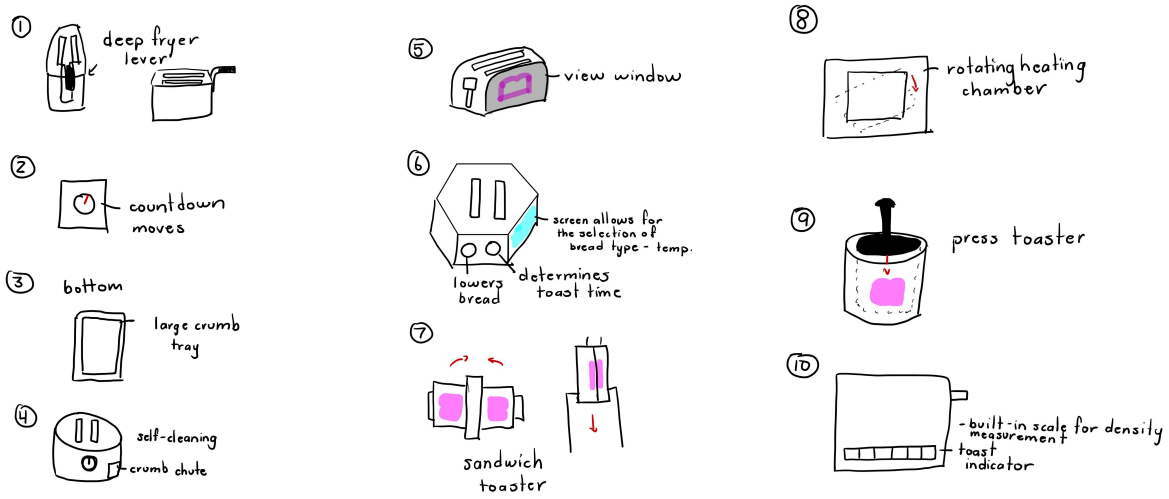
1. Safety First: Ensuring the safety of users is the top priority. This includes making sure the toaster remains safe to touch, preventing mishaps such as toast popping out and falling, and avoiding the release of fumes or melting of materials during use. Safety measures should also encompass environmental safety standards to mitigate potential hazards.
2. Social Responsibility and Efficiency: Upholding social responsibility standards, such as avoiding child labor in manufacturing processes and promoting better energy efficiency as IoT technologies develop, is crucial. This includes sourcing materials ethically, using sustainable manufacturing practices, and designing for energy conservation without compromising functionality.

3. User-Friendliness: Prioritizing user-friendliness ensures that the toaster is accessible and easy to use for all users, including extreme users like the elderly. Design specifications should consider ergonomic factors, intuitive controls, and clear indicators to enhance usability and user satisfaction.
4. Speedy Toasting: Responding to the demand for speedy toasting, design specifications related to toasting time and efficiency should be addressed. While not compromising safety or quality, optimizing the toasting process to reduce waiting time can enhance user experience and convenience.

By aligning design priorities with safety, social responsibility, user-friendliness, and speed, the toaster design team can create a product that not only meets functional requirements but also contributes positively to user well-being, environmental sustainability, and market competitiveness.

Ideation

The following sketches were produced before developing a prototype. A total of 60 sketches, 10 produced by each team member, were evaluated and the ones determined to be most in line with the problem statement and design requirements were further developed into low-fidelity prototypes.



The above sketches map onto the design requirements in the following ways:

1. Sketch 1
    a. The design meets the design requirements
        i. Design should be user friendly for various demographics, including children and elderly people
            1. The large lever allows for the toast to be raised enough so that there is not need to place fingers anywhere near the heating elements
        ii. Toast shouldn't pop out of the toaster and fall
            1. Lever allows for the movement of toast to be at the discretion of the user

2. Sketch 2
    a. The design meets the design requirements
        i. Should consider ways other than numbers to indicate toasting
            1. Countdown timer would work like a mechanical kitchen timer
        ii. Should consider kinesthetic experience interaction; ie: Motions that direct toasting, resistance in a dial
            1. Timer would have resistance and tick as it counts down
        iii. Design should be user friendly for various demographics, including children and elderly people
            1. Timer if intuitive and builds on other kitchen appliances
        iv. Light & sound cues
            1. Tick provides a sound cue as bread is toasting and a ping would sound at completion
3. Sketch 3
    a. The design meets the design requirements
        i. Easy to dismantle in order to safely clean
            1. Large tray allows for safe cleaning
        ii. Toaster should be easy and safe to clean on the inside
4. Sketch 4
    a. The design meets the design requirements
        i. Toaster should be easy and safe to clean on the inside
            1. A self-cleaning toaster with a crumb chute would make it safe to remove the debris from the inside of the toaster
5. Sketch 5
    a. The design meets the design requirements
        i. Should consider ways other than numbers to indicate toasting
            1. View window allows for the user to see toasting as it happens
        ii. Should consider kinesthetic experience interaction; ie: Motions that direct toasting, resistance in a dial
            1. Users would be able to terminate the toasting once they see the browning of their choice
6. Sketch 6
    a. The design meets the design requirements
        i. Should consider kinesthetic experience interaction; ie: Motions that direct toasting, resistance in a dial
            1. Display offers a different experience compared to a just a knob
        ii. Light & sound cues
            1. The screen provides a visual of the toast
        iii. Toast shouldn't pop out of the toaster and fall
            1. Lever is replaces my knob that dictates the height if the toast
7. Sketch 7
    a. Users would be able to toast two slices at once with food in between
8. Sketch 8

    a. Uneven toasting was a frustration among many users during interviews. A rotating chamber would mitigate this issue.
9. Sketch 9
    a. User interviews revealed students were frustrated that they could not toast bigger items. This toaster would allow for larger foods, like croissants and pizza, to be toasted without the danger of them getting stuck and becoming a fire hazard.
10. Sketch 10
    a. The design meets the design requirements
        i. Should consider kinesthetic experience interaction; ie: Motions that direct toasting, resistance in a dial
            1. Toaster indicator would allow users to select a button based on the desired browning color
        ii. Should consider ways other than numbers to indicate toasting
        iii.

To decide which sketch would be developed into a prototype, a reevaluation of the sketches and their compliance with the engineering requirements and design specifications was conducted. It is clear that some sketches met fewer requirements and they were therefore determined insufficient for further development. After an initial round of elimination, the remaining sketches were evaluated by the team; however the toaster as a whole was not selected to be further developed.

Future Work

The prototyping process would be divided into three distinct phases, each serving a specific purpose and utilizing different materials and methods:

1. Low-Fidelity Prototyping for Form (Foam and Tape):
In the initial phase, low-fidelity materials such as foam and tape would be used to create a basic representation of the toaster's form.The primary goal of this phase is to capture the overall shape, size, and layout of the toaster. It helps visualize the physical appearance and dimensions of the final product. User feedback during this phase would focus on ergonomics, aesthetics, and general impressions of the toaster's design. This feedback would inform iterative adjustments to the form before proceeding.

2. Low-Fidelity Prototyping for Function (Foam and Tape Continued):
Building upon the form prototype, the second phase of low-fidelity prototyping would shift the focus towards testing functional aspects. While still using foam and tape, this phase involves adding basic functional elements such as movable levers, buttons, and slots to simulate the operational features of the toaster. User testing during this phase would involve interactions with the prototype to assess usability, ease of operation, and feedback on initial functional design concepts.

3. Mid-Range Prototype for Shell (Higher Fidelity):
The final stage of prototyping transitions to a mid-range prototype that incorporates more realistic materials for the outer shell of the toaster. Materials such as plastic or composite

materials would be used to create a sturdy and representative shell of the toaster, including details like surface texture and finish. While CAD may have been used in the design process, the mid-range prototype would not integrate complex technology components. Instead, the focus remains on the physical structure and appearance. User research and testing would continue during this phase, focusing on the overall user experience, durability, safety features, and any remaining usability issues.

Between each prototyping phase, user research sessions would be conducted to gather feedback, insights, and suggestions from potential users. This iterative approach ensures that design improvements and refinements are informed by user preferences, needs, and behaviors at each stage of development. The transition from low-fidelity to mid-range prototypes allows for gradual refinement and validation of both form and function before moving towards more advanced stages of development or production.

The design team decided not to move forward with prototyping a toaster. The decision was based on several key factors that were carefully considered by the group:

1. Social Responsibility Complexity: One of the primary reasons for not advancing with the toaster project was the complexity involved in ensuring its social responsibility. This included considerations such as ethical sourcing of materials, avoiding child labor in manufacturing processes, and promoting sustainable practices throughout the product's lifecycle. The extensive research and resources required to navigate and comply with these social responsibility standards were deemed too challenging to undertake within the project timeline and scope.

2. Safety Assurance: Another significant concern was the need for more time to ensure the safety of the toaster design. Safety is paramount, especially in household appliances like toasters that involve heating elements and electrical components. The group recognized that thorough testing, compliance with safety standards, and risk assessment would require additional time and resources to execute effectively.

3. Strategic Decision Due to IoT Advancements: Additionally, the rapid development and advancements in Internet of Things (IoT) technologies played a strategic role in the decision-making process. Given the evolving landscape of smart home devices and connected appliances, it was deemed strategic to wait and observe how IoT integration in toaster technology would progress. This strategic approach allowed the group to stay informed about emerging trends, technological innovations, and consumer preferences related to smart toasters.

In summary, the decision not to proceed with prototyping the toaster was based on the complexities of ensuring social responsibility, the need for additional time to ensure safety compliance, and a strategic decision to monitor IoT developments. These considerations collectively led the group to prioritize thorough planning, strategic alignment, and responsible decision-making in product development endeavors.

Appendix

A.

Interview Questions – Toaster

- Demographic information
    - Age, Pronouns
- How often do you use a toaster?
- What do you normally toast? What else do you want to put in a toaster?
- What is your preferred level of toast? (Using reference image)
- How long do you have to wait to toast? How long does the process of toasting itself take?
- Do you prefer one dining hall's toaster over another? Why?
- What frustrates you most about Brown dining's toasters?
    - Have you ever witnessed a toaster incident or mishap?
- What makes a good toast?
- Have you ever seen a toaster be maintained or cleaned?
- If you could choose a toaster for the ratty to purchase next year, what would it be? What features would it have?
- Do you prefer a personal-use toaster or a communal one (like this one here)?
- Do you have any specific routines or memories based around the use of a toaster?

B.

22, student
Toasts occasionally, when they "feel like it" – more often at home where toaster is at reach
Toasts bread and sometimes frozen waffles
Would be curious to toast croissants
Perfect toast is soft and warm, not super brown
Wait doesn't feel like a lot when you put the bread in the toaster
A toaster that seems newer is best because it won't be "nasty" inside
A simple toaster is the perfect toaster, anything that gets the job done without requiring too much tech-y-ness - "I use it because it's a set it & forget it kind-of-thing"
Toasts as late snack at home with siblings is a fond memory

Toaster
21, student
Uses toaster daily for breakfast, sometimes for other meals if food is not good at the hall
Toasts bread and bagels, whatever bread they have at the dining hall
Doesn't have any desired items to toast
Usually waits a few minutes for the toaster to be free and toasting takes 3-4 minutes – not annoying because they walk around the hall and eat other food in the meantime
Best toaster is where it's not crowded, they look the same otherwise
Frustrations are uneven toasting
Tried to toast a bagel but it got stuck and seemed like there was smoke
Perfect toast is warm and a bit crunchy but not much
Wants to have a toaster that gives the exact type of toast every time – if there's a setting to pick from toasting types
No fond memories

21, almost 22, student
Almost never uses his toaster at home - stopped eating bread around 17-18
5th row, 3rd column toast preference
He would walk away and come back occasionally to check in on the toast, wouldn't stand next to it or even in the same room
Lever breaking was very frustrating, didn't go all the way back up and sometimes didn't go down easily either
Crispy without being burnt is the perfect toast
Mini toaster is better, not the conveyor belt - "it feels more efficient even though it's not, its got an alert sound"
No specific memories

Student 1, 20, she/her

- Frequently (daily use)
- Blueberry waffle made in dorm toaster
- Doesn't use dining hall toaster
    - "Finnicky as fuck and burnt my bagel"
- Only tried ratty toaster
- Cross contamination in dining hall (allergic to sesame and people use sesame bagels in the toaster)
- Never seen a toaster be maintained or cleaned in dining hall
- FEATURES: self cleaning, de sesame-ing, newer, less burning, "less awful"
- Personal toaster: can adjust time and temperature without people getting mad
- Toaster toastiness: around B or C (medium light to medium)
- Mom tried to burn down house with toaster trying to make toast, toasted it for too long (Toaster oven)

- If you get to dining hall around non-peak time, only waiting a few minutes and only a few minutes to toast

Student 2, 21, she/her

- Uses toaster once a month (at college); at home its like 3 times a week
- Has toaster but doesn't buy bread
- Usually toasts bread or a bagel; wishes we could toast pizza
- Toast toastiness: C
- Does NOT use dining hall toaster ("cuz im scared")
    - There's a lot of people, embarrassing, in case you make a mistake
- Toast comes out unevenly toasted in dining hall toaster
- Mishaps: People taking each other's bagels
- What makes bad toast? Seedy bread
- Definitely have never seen the inside of a toaster be cleaned/maintained
- Prefer a toaster oven style to a rotating toaster or popup
- Toast gets stuck and dropping it on the floor

Student 3, 19, she/her

- Uses toaster once a month
- Normally toasts slices of bread and bagels
- WANTS TO PUT CROISSANT IN THE TOASTER!!!
- Toast toastiness: B/C
- Never usually has to wait in line to toast, waits about 2 to 3 minutes for toasting to finiush
- No preference with brown dining toasters
- Brown toasters take "long as hell" and sometimes don't toast correctly
- Witnessed a toaster fire and bread getting stuck (with smoke coming out)
- Never seen a toaster be maintained or clean
- Features: go quicker, better alignment with setting and actual toastiness
- Prefers communal to personal -use, it fits more because its rolling
- No specific memories

C.

Observations

- No one is changing the setting, leaving it at what Jules set it to initially
    - One person had to retoast because they didn't adjust setting
    - One girl changed it
- Standing and waiting directly in front of the toaster until done
- People tend to toast one thing at a time (like in a line) rather than side by side
- ALWAYS RUNNING, no one turns off or on during the day
    - Even during lunch or dinner
    - Tried to turn off main one, switch was too hot for us to touch (for long enough to actually switch it)
- Can smell the toaster when sitting at nearby tables, even when not actively toasting
- Second toaster spotted! No one seems to be using it because it's in the corner
    - Appears to be a better toaster though (Design wise)

    - Also turned on and running
    - Cleaner and newer looking
    - 729 dollars new
- First user who walked away but he ended up circling back and waiting; Didn’t change setting (came out burnt