Fall 2021 | Sophomore Studio I | Lara Goulart

Haptic Knife Design

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Rochester Institute of Technology
College of Art and Design
Industrial Design

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Who are we solving a problem for, and why do we need to solve it?

The goal of this stage is to gain insight into the user's unique abilities and needs. Empathizing allows us to begin to understand what the problems may be.

Reimagining knives to be more inclusive & haptically responsive for the visually impaired

Exercise: Blind Lego Assembly

In order to better empathize with the visually impaired, we tried to assemble Legos with blindfolds on. A seeing person tried to instruct the blindfolded partner on how to construct a specific model.

We learned that it was easier when pieces had distinct parts, or landmark spots. Parts could be identified by size, color, and materials.

It was difficult to keep track of where things were, and things got frequently knocked over.

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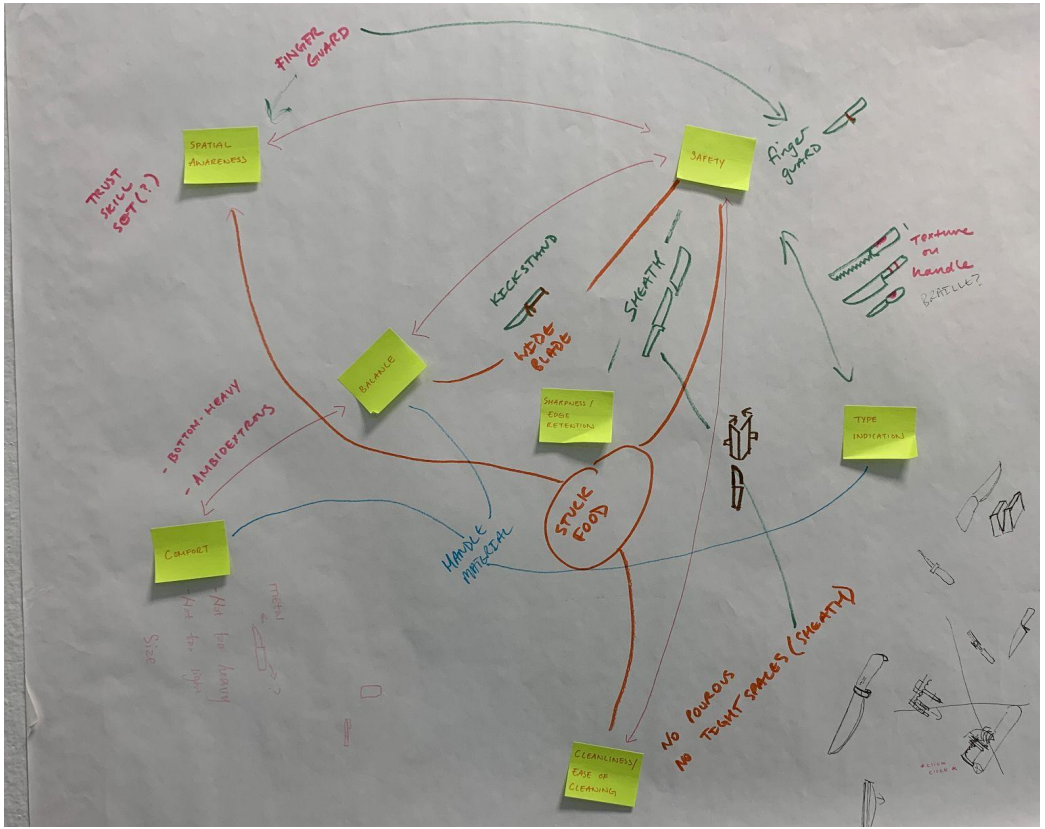
What is the core problem we need to solve?

The goal of this stage is to understand the many facets of the problem we are working with.

Identifying Problems

The typical kitchen knife presents issues because there is minimal haptic communication between the blade and the handle. This makes it difficult to know where the blade is at all times. The blade is also directly exposed to the user. These two factors make a typical knife very dangerous for a visually impaired person.

Other potential problems we spotted were things like knocking chopped food off of the blade safely, a way to establish the sharp and dull edges of the blade, and the spatial awareness needed to understand the size of what was being cut.



Competitive Benchmarking

Competitive benchmarking helps us understand what is already on the market that may help solve our problem.

This example solves the issue of spatial awareness well with a finger guard. This acts like a bumper between the blade and fingers, and pivots to give the user a guide to the depth of their cutting. The trigger of the guard can also be used to clear food from the blade.

However, this model presents some issues. It is inconvenient to disassemble the knife for cleaning, and there is minimal haptic response in terms of texture and material differentiation.

Competitive Benchmarking

This model is more haptically involved. The dual handles allows for the user to have better balance and control over the blade. It also helps the user know where the blade is, as the sharp side is always down, there is no forward or backwards position, and the handles mark the ends of the blade. The handles also keep the user's fingers away from the blade. The curved blade allows for haptically interactive movement, by rocking the blade.

This knife makes it harder to stabilize the food underneath the blade, and there is only one grip option. This limits the potential usefulness of the knife.

Competitive Benchmarking

This model uses a plastic serrated blade, instead of a smooth metal blade. These are often used for children who are learning to use knives. In combination with the rounded tip of the knife, this limits potential risks. The handle also is more haptically involved with the blade, so that the grip provides additional information about the blade and what is being chopped. The downfall of this knife is that the serrated plastic blade is much less effective for cutting food. There is also no protection around the blade, leaving fingers potentially exposed.

Problem Statement:

How might we reimagine a knife to be more inclusive using haptic interactions so that it is still safe & effective for the visually impaired.

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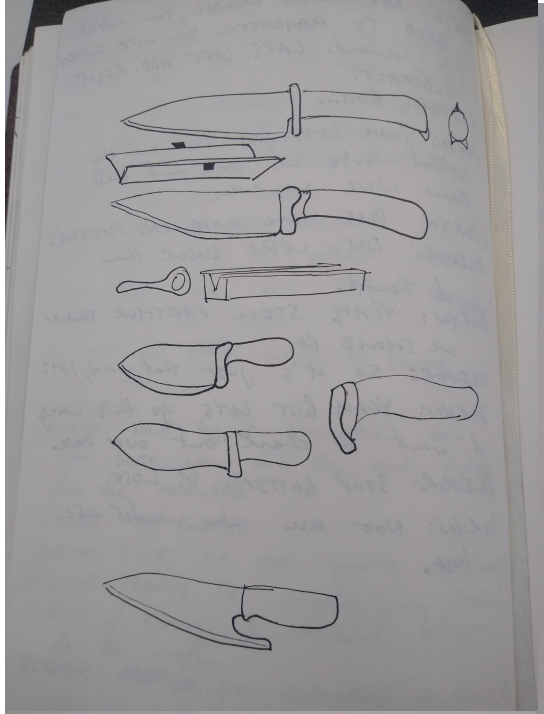
How do we solve the problem?

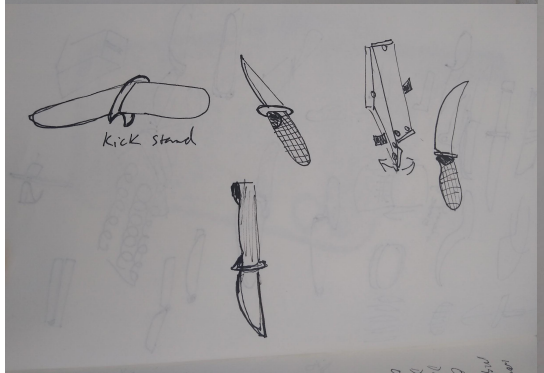
This stage is starting to think about how we can solve the problem now that it is defined. We need to consider all of the different aspects of the problem and all of the different possible ways to address them.

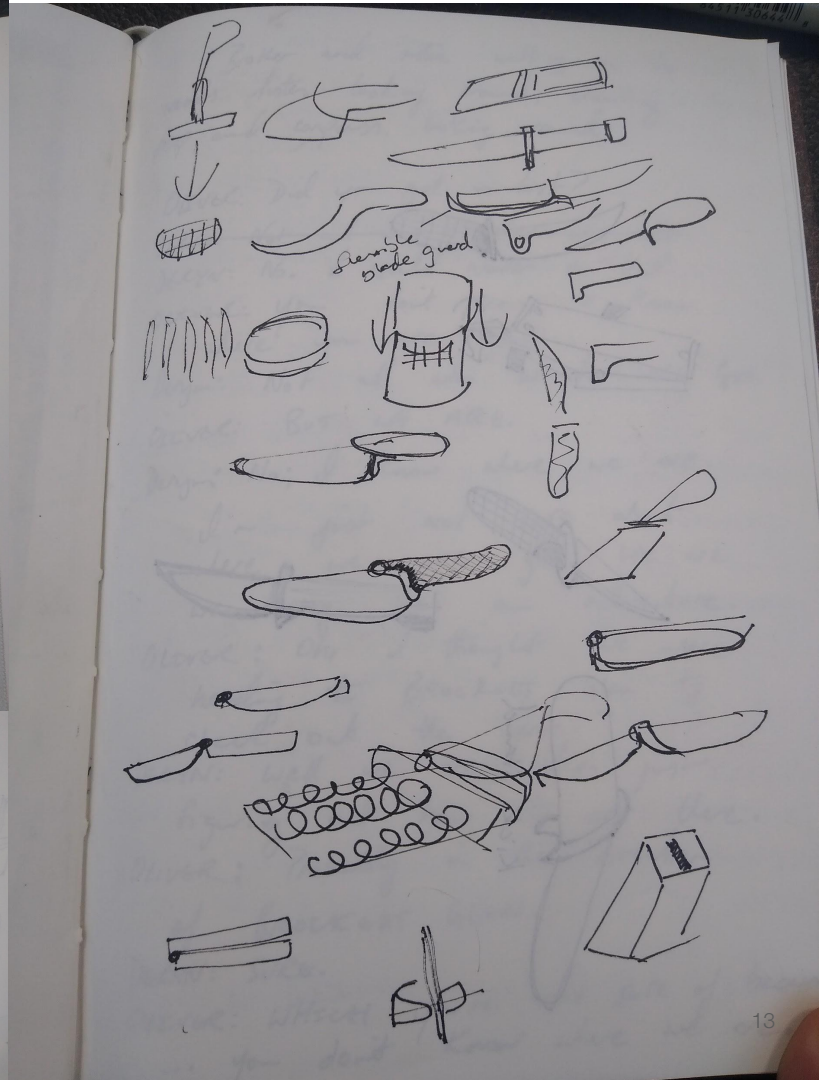
Starting to Sketch

Our initial sketches focused on how to keep the user aware of the blade while using it. We considered kickstands, different grips, styles and types of blades, and many other ergonomic factors involved.

This also helped us consider the elements of a traditional knife and further understand how the traditional knife needed to be adjusted for the blind and visually impaired.







3D Sketching

After sketching on paper, we began making 3D versions of our sketches to better understand the dimensionality our designs required. This process used chipboard, paper, and other random supplies around our workspace. We also did some Lego mockups to further ideate different forms.

The different 3D sketches helped us continue to sketch on paper and pick designs to start prototyping with.

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How do we make the solution to the problem happen?

Now we have a grasp on the problem and how we might solve it, so the focus shifts to how we put the many solutions together. We also need to troubleshoot and discover what does and doesn't work.

Prototype 1

This prototype uses a finger-based grip in order to keep the users fingers away from the blade. It can be used with one alone, or two together. Using one at a time allows one hand to hold the food being chopped stable, and the other uses the knife to chop either up and down or in a rocking motion. Using the two together is similar, in that one can be used to stabilize, and the other can chop. The advantage to this setup is that the flat faces of the blades can slide along each other to prevent any injury to fingers near the blade.

Prototype 2

The prototype here uses the rounded bladed to help stabilize the user. It can either be rocked back and forth to chop, or brought up and down. The simple grip allows multiple different ways to hold the knife, so that each individual may be as comfortable and confident in their grip as possible. The front end would also be serrated, in order to hold down or crush the food being chopped.

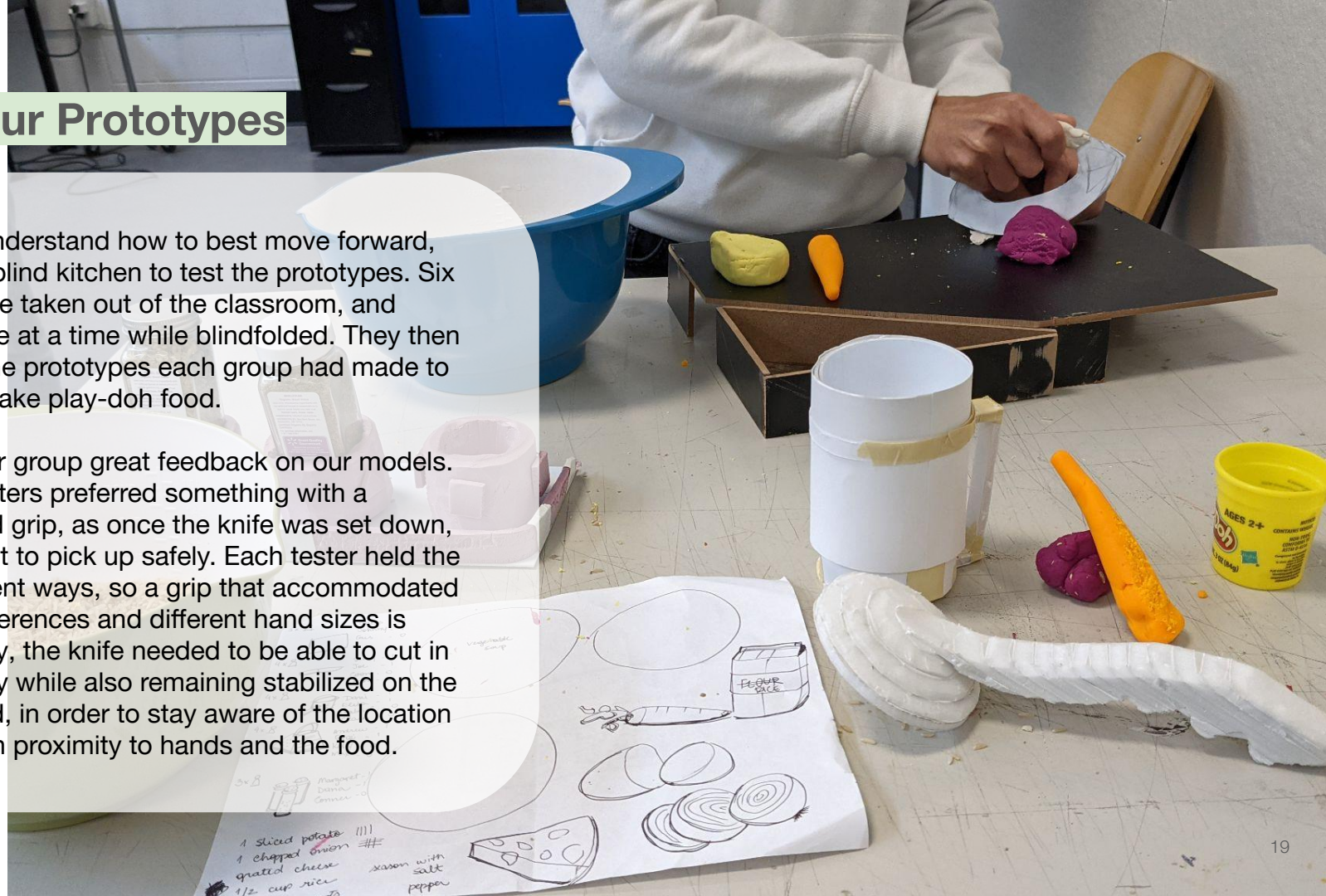
Prototype 3

Prototype 3 is most similar to already existing, regular knives. It has a large blade that is exposed, which makes it very easy to chop a large variety of foods, but is also the most dangerous. The grip is ergonomic, so it is easier for the user to understand how to hold it. The height of the blade also allows for the user to scoop the chopped food with the blade. You could also use the blade to move food around the cutting board.

Testing Our Prototypes

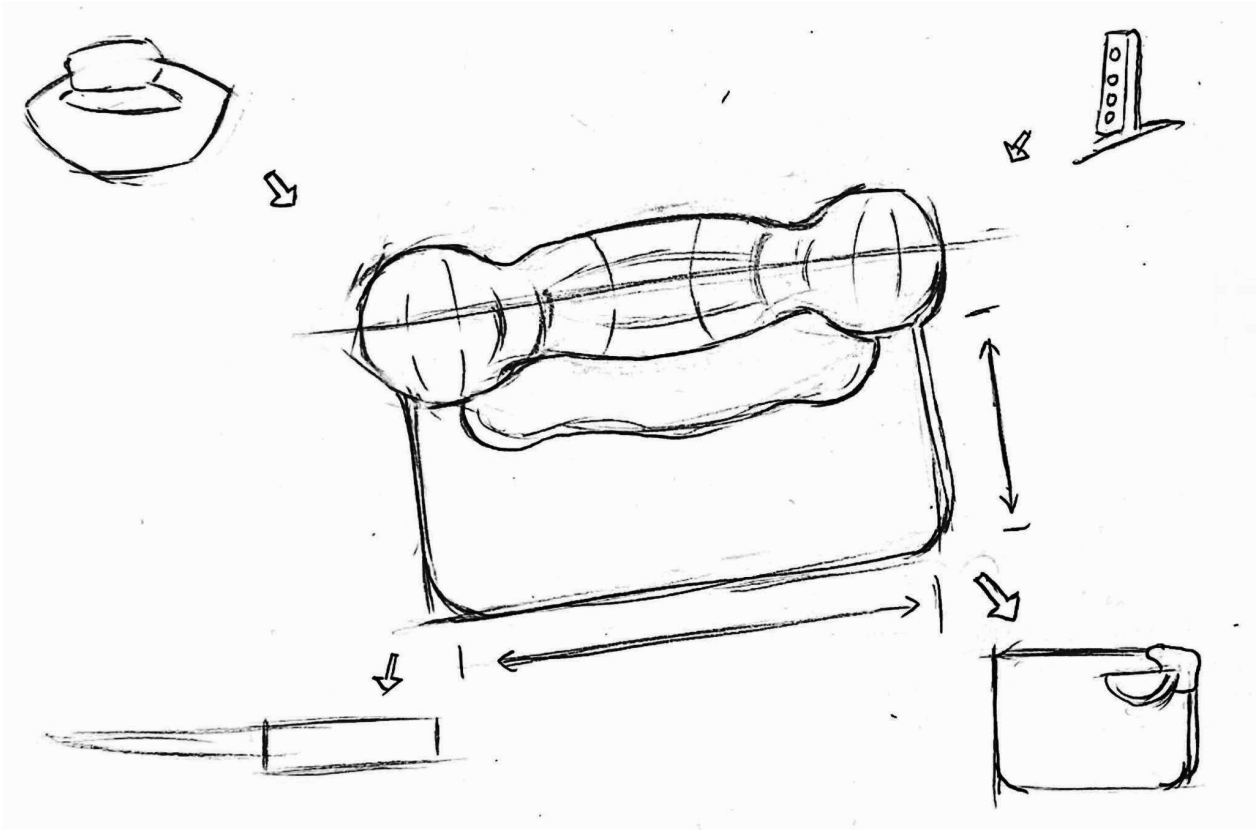
In order to understand how to best move forward, we set up a blind kitchen to test the prototypes. Six students were taken out of the classroom, and reentered one at a time while blindfolded. They then had to use the prototypes each group had made to attempt to make play-doh food.

This gave our group great feedback on our models. Our blind testers preferred something with a distinguished grip, as once the knife was set down, it was difficult to pick up safely. Each tester held the knives different ways, so a grip that accommodated different preferences and different hand sizes is critical. Lastly, the knife needed to be able to cut in a familiar way while also remaining stabilized on the cutting board, in order to stay aware of the location of the knife in proximity to hands and the food.



Prototype Testing Results

Criteria	**Concept 1**		**Concept 2**		**Concept 3**	
Safety	**5**	Easy to pick up, fingers away from blade	**3**	Harder to pick up, blade is exposed	**1**	Lots of exposed blade
Sharpness	**2**	Shallow blade prevents deep cuts	**4**	Easy to glide with cuts	**5**	Many ways to cut, deep blade allows deep cuts
Comfort	**4**	Finger holes provide an easy grip	**4**	Soft and ergonomic handle, multiple grip positions	**1**	Handle is undefined, no space to rest hand
Spatial Awareness	**2**	Lots of movement	**4**	Rocking allows an anchor point	**4**	Easy to anchor
Final Scores	**13**		**15**		**11**	



Concept Selection

The design for our final solution came from the highest scoring elements of the prototype testing results. The motion of the knife was used from prototype 1, the ergonomic handle and grip was used from prototype 2, and the large, flat blade was taken from prototype 3. In combination, it creates a knife that is safe and easy to use while still being a highly effective knife.

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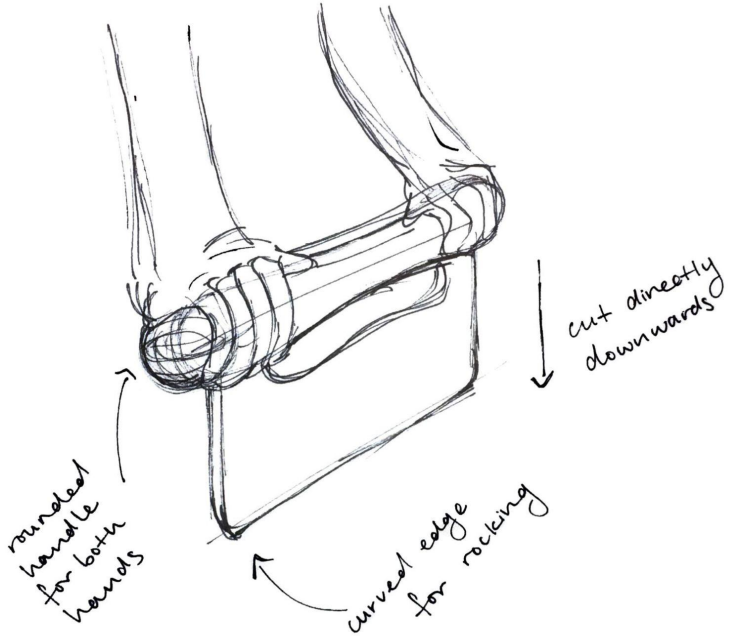
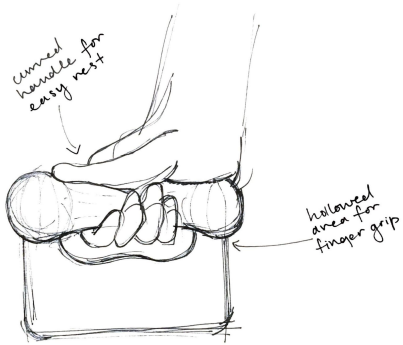
What is the best solution to the problem, and how do we make that happen?

This stage focuses on the best solution and how to get there. This considers everything we have worked on so far and combines it into the final prototype.

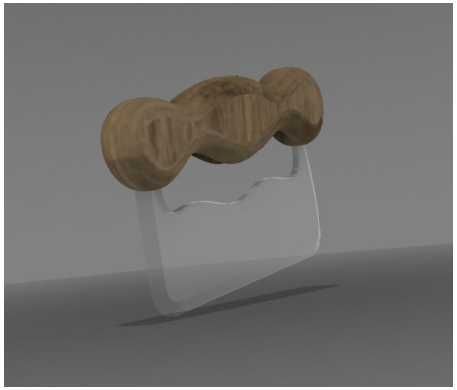
Interactions and Ergonomics



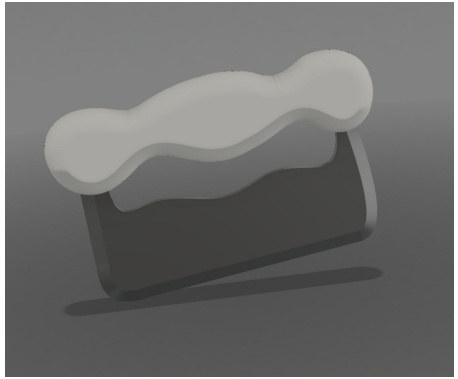


The design of this knife allows for many different grips and actions, making it usable for many differently-abled people. The handle is rounded so that it could be used as a one or two handed grip comfortably. The area below the handle is hollow so the fingers can comfortably grab the handle. It also makes the knife safer to pick up, because the rounded handle gives the knife a larger and more distinct vertical profile. This means less grasping around for the knife and accidentally grabbing the blade. The corners of the knife are curved so the knife can be used in a rocking motion that is distinctly anchored, but it can also be used to cut directly downwards.

Materials, Color, and Finish



For prototyping, we decided using a wooden handle and an acrylic blade would be the most practical way to communicate our idea. The wooden handle could be shaped very precisely on the lathe, with a soft finish that would feel somewhat similar to a soft silicon. The acrylic blade would be easy to shape and sharpen, and was readily available in the shop. The weight of the acrylic also balanced the wooden handle nicely.



Considering mass production and sale of this knife, we decided that a soft silicon handle would be best. It would be a distinct, easy to clean material. For the blade, we would use stainless steel, as it would be easiest to get sharp and would stay sharp best. The silicon could also be manufactured in bright colors, as many visually impaired people can still see some high contrast colors.

Constructing the Final Model

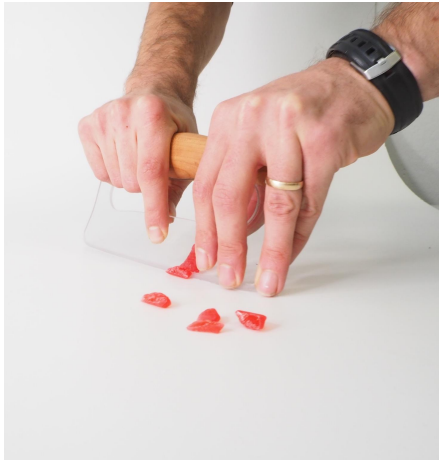
Once we had sketched out the final prototype, we began construction. We decided on size by measuring the smallest and largest hands in our group, and making a handle that would accommodate both. We then used the lathe to carve out a curved handle. In that handle, we cut a groove that accommodated the acrylic blade. Then, we sanded the blade to be sharper, and sanded the handle to be smoother. We put the pieces of the knife together and finished it with mineral oil.

Final Product

The goal of this knife was to be more inclusive by way of haptic interactions, but still be safe and effective. Haptics on this project include the rounded corners of the knife, that allow it to rock back and forth while being anchored on the cutting board. The handle is curved to indicate possible hand positions, and the height of the handle gives the knife a vertical profile that sticks up, so that the user doesn’t accidentally grab the blade.

In the Kitchen

This knife is also very safe. The haptic interaction make it so the user has some spatial awareness of the knife. The two-handed grip makes it so the user knows exactly where the knife starts and stops. Additionally, the cutout below the handle gives the user a space to wrap their fingers around and easily pick up the knife without touching the blade. The height of the knife also lets the user put their fingers down on the flat part of the blade to better feel what they are cutting.



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