



CONSTRUCTION SPEAKER



BENJAMIN TROST
SOPHIA THOMAS

OVERVIEW



- BEN TROST



- SOPHIA THOMAS

1

UNBOXING /DISASSEMBLY

4

IDEATION/SKETCHES

2

UNDERSTANDING THE USER

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3

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FINAL MODEL + ASSEMBLY

PROJECT BRIEF

Engage in the challenge of reverse engineering and reimagining how a product can better serve a particular user group. Understand user requirements through appropriate design methods and develop design iterations. Aim to improve the object's design and functionality, utilizing manufacturing principles to 3D model, 3D print, and assemble the final solution. Emphasize user experience, evaluate how the object's features support the needs of a chosen target user. Iterative designs are a core aspect of this project; explore foam prototypes before finalizing the solution. Additional components can be added if seamlessly integrated to ensure functionality remains intact.

PHASE 1

In Phase 1, we focus on reverse engineering an existing Bluetooth speaker to understand how it works, who it serves, and how it's made. We disassembled, documented its components, and researched our target users to uncover needs, habits, and challenges. Using design research methods, competitor analysis, mood boards, and a short literature review, we built a strong foundation of insights to guide the subsequent phases of our design process.

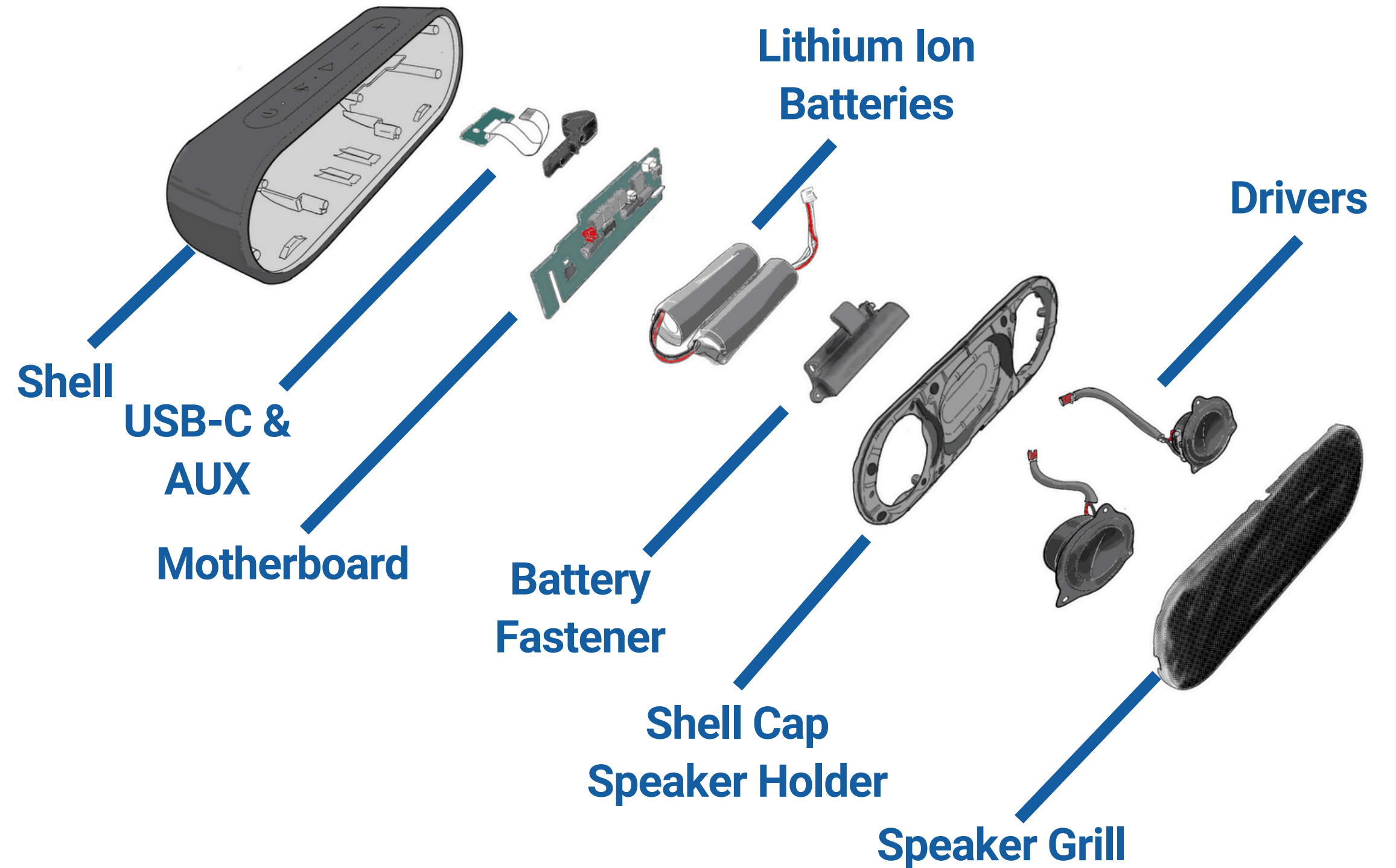
PERSONAL EXPERIENCE

- Unboxing experience was smooth and pleasant
- Instructions make sense, and the buttons are intuitive
- Speaker gets to a good volume and holds battery
- Built sturdy and is extremely waterproof
- Good Bluetooth Range



TEARDOWN AND COMPONENTS

Engage in the challenge of reverse engineering and reimagining how a product can better serve a particular user group. Understand user requirements through appropriate design methods and develop design iterations. Aim to improve the object's design and functionality, utilizing manufacturing principles to 3D model, 3D print, and assemble the final solution. Emphasize user experience, evaluate how the object's features support the needs of a chosen target user. Iterative designs are a core aspect of this project; explore foam prototypes before finalizing the solution. Additional components can be added if seamlessly integrated to ensure functionality remains intact.



DISASSEMBLY STEPS



STEP ONE

Remove the Speaker Grill with a wedge or flathead screwdriver. It's held on with a little bit of glue and friction, so using a bit of force while going around the edge safely takes it off.



STEP TWO

Unscrew the 14 screws embedded in the shell cap holding the speaker together. Once done, the shell cap should be held in place by the drivers, which are still connected to the motherboard.



STEP THREE

Remove the glue with a screwdriver that surrounds the drivers to the motherboard connections, then safely yank the plugs out. You will then be able to full detach the drivers and shell cap.

DISASSEMBLY STEPS



STEP FOUR

Remove the screws that keep the battery fastener in place. Then slowly pull the batteries away from the inside while keeping them connected to the motherboard.

Find the connection to the motherboard and remove them the same way as the drivers



STEP FIVE

After removing the foam around the motherboard. There are two tabs holding the motherboard in, then need to be pried away without damaging the motherboard. Then the motherboard will slide out with a little force. Make sure to safely undo the ribbon cable attached to the AUX/USB-C, as well as the cable attached to the motherboard on the back.



STEP SIX

Pry away the glue just below where the ribbon cable is, and do so until the whole AUX/USB-C Fastener and screws are showing. Then unscrew the fastener and remove the AUX/USB-C module.

DISASSEMBLY EXPERIENCE

Learned about how the product is:

- Made
- Manufactured
- Assembled
- Easy to disassemble quickly

Notes:

- The ability to access the motherboard and components is easy
- Learned what screws and processes are used in construction





THE USER

Construction Workers 30s-50s

Construction workers spend long hours on active job sites surrounded by constant noise, dust, heavy equipment, and unpredictable weather. Their tools and devices must withstand tough conditions while being easy to operate during fast-paced, physically demanding tasks. Music and communication play an important role in improving morale and maintaining focus throughout the day.

Key Needs on Site:

- **Durability:** Products must survive drops, impacts, and exposure to dust, mud, and water.
- **Glove-Friendly Interaction:** Large, tactile controls that can be operated without removing gloves.
- **High Volume Output:** Audio equipment needs to cut through saws, drills, and heavy machinery.
- **Portability & Mounting:** Easy to move between work areas, with flexible options like clamps, straps, or magnets.
- **Power Reliability:** Long battery life and alternative charging solutions like solar panels, or tool battery compatibility.
- **Simplicity:** Fast setup and intuitive use, since workers don't have time for complicated features.



UNDERSTANDING THE USER

WHEN AND WHERE WOULD THEY USE A PRODUCT LIKE THIS?:

- On the site broadly
- While working on jobs or on break as well
- The sites could be anything from your average house construction to a skyscraper
- Sometimes used in tighter spaces
- Areas with varying temperatures
- Areas without power outlets

WHAT ARE THEIR HABITS, CHALLENGES, AND PREFERENCES?

- High volume
- Large battery
- Durability
- Good sound quality that lasts
- Price is not a concern as long as the product holds up to the value
- Prefer "durable and heavy" over "light and fragile"
- Radio would be nice
- Place to put the power cord

WHAT MIGHT THEY EXPECT OR VALUE IN ITS FUNCTION OR DESIGN?

- Because of the nature of construction sites, it should most likely be fastened or attached to something, be waterproof, and tough against all elements, as well as generally durable
- Easily portable
- Variety in ways for the speaker to sit, and or be held or stuck in certain spots (Mounting)
- Tool batteries can be charged, or are easily rechargeable or long-lasting batteries
- audio jack,
- Spot for phone



INSIGHTS

AMAZON REVIEWS

DEWALT SPEAKER

- It's rugged. The black ends are rubberized.
- Bluetooth, the connection is FAST.
- Front speaker screen/grill is metal.
- It's also a power bank! It has a traditional USB port, so I can charge my phone or other USB devices
- It has a space in the handle which can hold your phone

MILWAUKEE SPEAKER

- It's also a power bank! It has a traditional USB port, so I can charge my phone or other USB devices
- It has a space in the handle which can hold your phone
- It has two mounting holes as well as a hole in the handle
- Another big win: it runs on Milwaukee M18 batteries, so if you're already in the Milwaukee ecosystem, this is a no-brainer.

KLEIN SPEAKER

- AMAZING DURABILITY! Connects quick. Easy to use. Sounds good.
- Magnet strength/overall speaker durability: I left this attached to a vehicle while I went driving on-road and off-road for an entire day.
- Insanely long-lasting battery
- Clip and magnet work fantastically.

W-KING SPEAKER

- It has a good, loud, and clear sound
- Battery life is extremely solid
- It looks great and is sturdy
- I use it at least 3-4 times a week from early afternoon to late at night. I haven't had it die on me yet.



DESIGN RESEARCH

- S** – Replaced the original plastic mold with a durable look of black and orange materials.
- C** – Integrated clamps with the speaker body for easy attachment to wood.
- A** – Adapted glove-friendly controls from industrial tools.
- M** – Modified the shape to be more compact but still durable.
- P** – Designed it so it could double as a charger.
- E** – Removed unnecessary decorative elements to focus on functionality.
- R** – Reorganized control layout for easy access while wearing gloves.

SCAMPER helped us explore improvements, making the speaker more durable, user-friendly, and practical for construction workers





DESIGN RESEARCH

IDEO CARDS - METHOD CARD

Arriving at the job site, this is how you would use the speaker:

- Close ports → Flip POWER ON → Flip BT to PAIR → Select “Jobsite Speaker” on phone → Mount → Enjoy.
- Use big flip switches and large buttons; no need to remove gloves.
- Brush sawdust off the front piece and solar surface when you see buildup — quick swipe with a gloved hand.



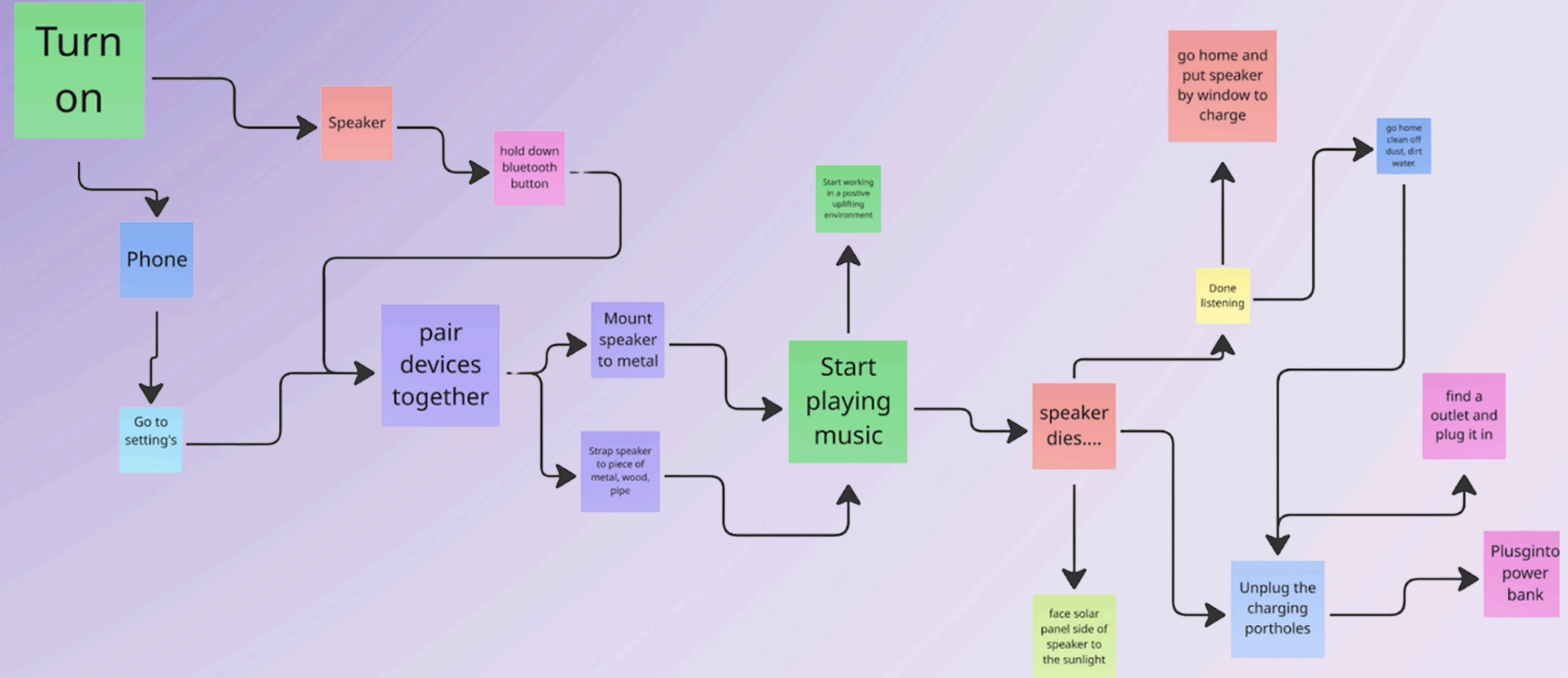
IDEO Cards guided our redesign to include larger buttons, bright color accents, and good clamp placement so the speaker is easier and safer to use in real-world jobsite conditions.



DESIGN RESEARCH

JOURNEY MAP

The journey map clarified where the design needed adjustments. It helped to show our pain points of Dust, noise competition, gloves, and rain. These pain points showed us our opportunities to improve by adding big buttons, clamp mount, rugged materials, and battery longevity.





DESIGN RESEARCH

CONNECTED CLOUDS

Connected Clouds helped us to visualize all aspects of the user experience and inspired features I hadn't originally considered, like integrating a multi-angle clamp and protective grilles to keep the speakers safe. It showed us many of the weak spots the Tribit speaker had that we could improve upon.





DESIGN RESEARCH

TARGETED PRODUCT

MORNING

Ben grabs his gear and his rugged jobsite speaker before heading to work. On site, he pushes the large power button with his gloved thumb. He pairs his phone instantly with the dedicated Bluetooth button and mounts the speaker onto a 2x4 using the built-in clamp.

- Design Insight: Glove-friendly tactile buttons
- Design Insight: Fast, intuitive Bluetooth pairing
- Design Insight: Clamp mounting options

MIDDAY

By noon, drills roar across the site, but Ben's speaker cuts through the noise. He cranks up the volume using easily identifiable buttons for volume. The crew smiles when their playlist kicks in, boosting morale. Even as sawdust flies, the grille keeps pumping clear sound without clogging.

- Design Insight: High-output drivers for noisy environments
- Design Insight: Simple, glove-friendly volume controls
- Design Insight: Dust-resistant grille

END OF SHIFT

At day's end, Ben pushes the power button off and tosses the speaker into his bag. It's scratched and muddy, but it still works like new. A quick rinse under a hose spray cleans it, thanks to sealed ports and water resistance. At home, he plugs it in so it's charged and ready for tomorrow.

- Design Insight: Water-resistant sealed ports
- Design Insight: Durable shell with protective bumpers

Design Insight: Easy to access charging



DESIGN RESEARCH

DIARY STUDY

Five Whys?

1. **Why do workers need a speaker?**

To play music or listen to audio while working on site.

2. **Why do they want to listen to music at work?**

It helps block out the constant noise of machinery and makes long shifts feel less draining.

3. **Why is blocking out noise and lifting mood important?**

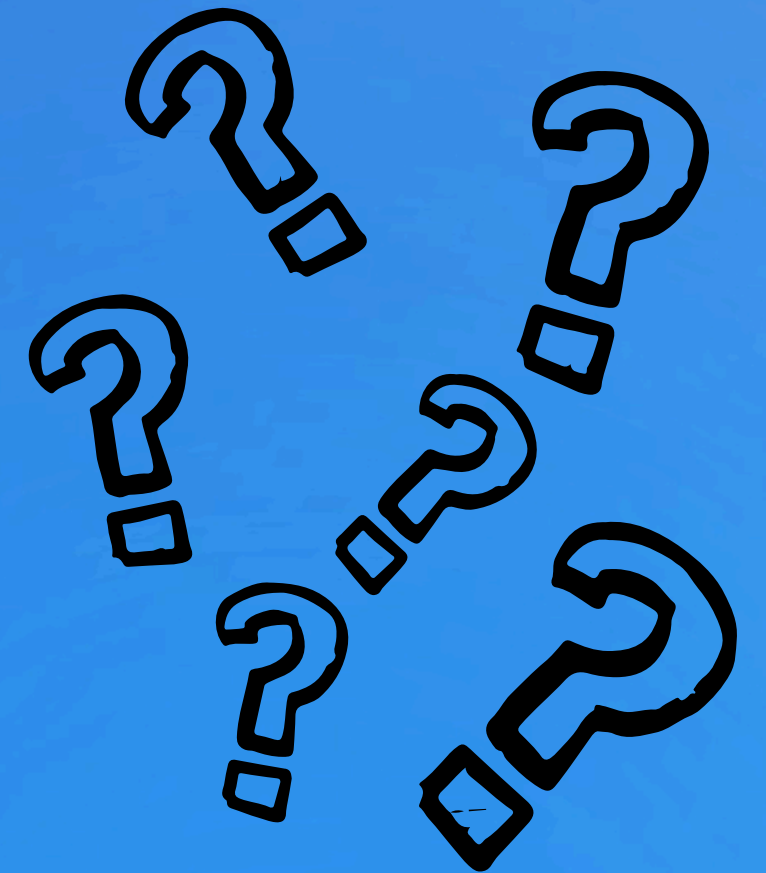
Because construction work is physically demanding and mentally tiring, music gives workers energy and boosts morale.

4. **Why is higher morale and energy necessary?**

It helps workers stay focused, reduces stress, and improves teamwork, making the job site more efficient and enjoyable.

5. **Why are efficiency and enjoyment valuable on the jobsite?**

Because when workers feel good and stay engaged, they perform better, stay safe, and want to keep coming back day after day. The speaker becomes more than just for music; it's a tool for well-being and connection within their team.



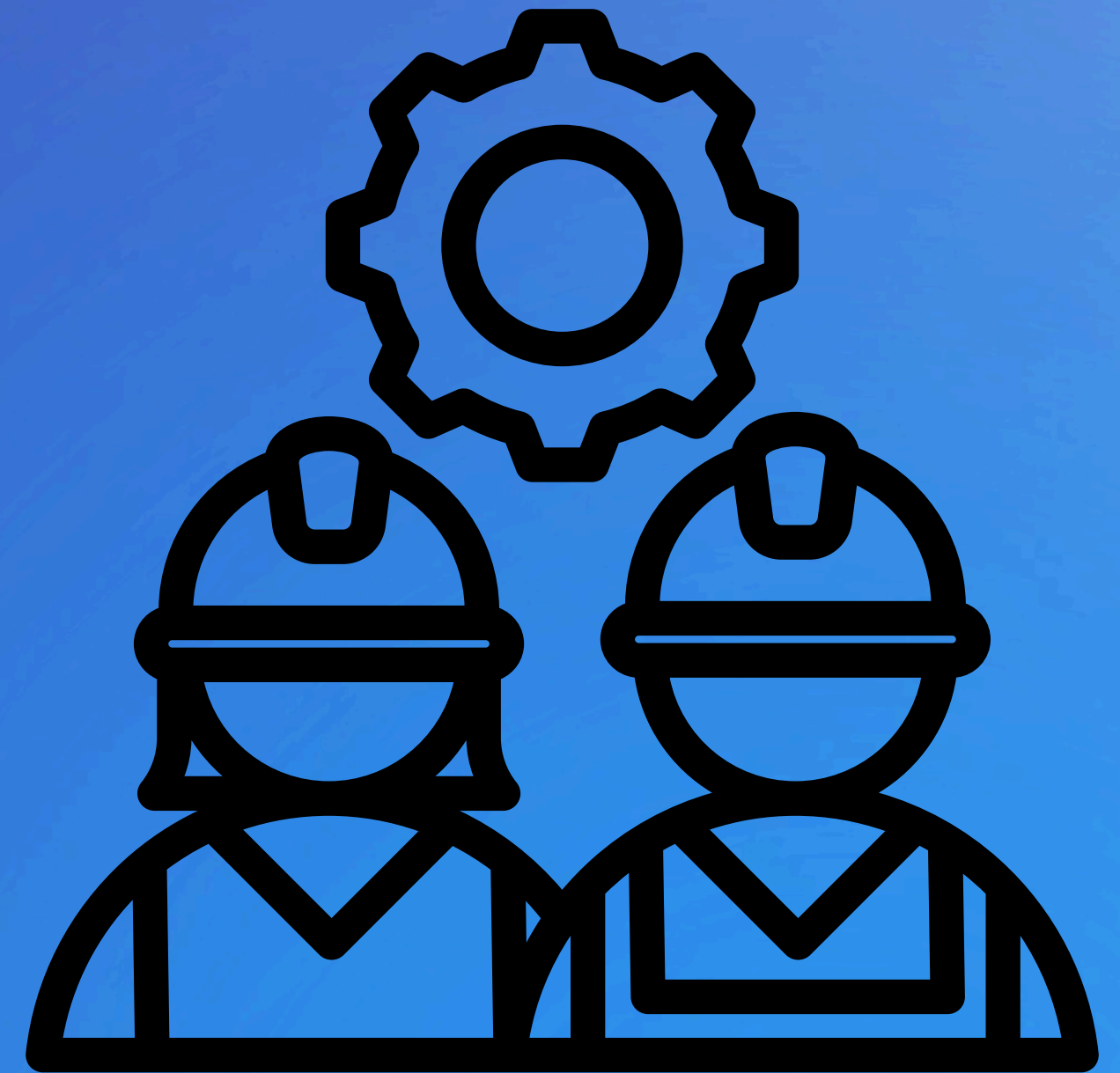


DESIGN RESEARCH

DESIRABILITY TESTING

Actual Insights from Interviews:

- Workers value durability over extra features.
- Volume and clarity are the most important factors.
- Some are skeptical of battery life and long-term reliability.
- Ease of transport and setup is critical.
- Brand and “cool factor” are secondary but still noticed.



MARKET/COMPETITOR RESEARCH



ANCOON

Description: Rugged IPX6 waterproof and shock-resistant speaker with a 10,000 mAh battery for long playtime.
Relevance: Ideal for workers needing durability and all-day performance in harsh jobsite environments.



W-KING D9 Series

Description: High-power 100 W peak output with dual woofers, tweeters, and IPX6 waterproof design.
Relevance: Best for loud, clear sound in noisy outdoor environments like large job sites.



W-KING D9 Series

Description: Mid-sized speaker with 20-hour battery, Bluetooth, USB-A & USB-C charging, and mounting options
Relevance: Perfect for easy placement on site, hands-free calling, and crew-wide audio.



DEWALT DCR010

Description: Compact, rugged design with USB charging port, Bluetooth 100 ft range, and phone slot.
Relevance: Great for tool-centric users needing portability and device charging.



Milwaukee 2891-20

Description: Six-speaker system (40 W), 100 ft Bluetooth range, and compatibility with tool batteries or AC power.
Relevance: Perfect for contractors using Milwaukee tools who want seamless battery integration.

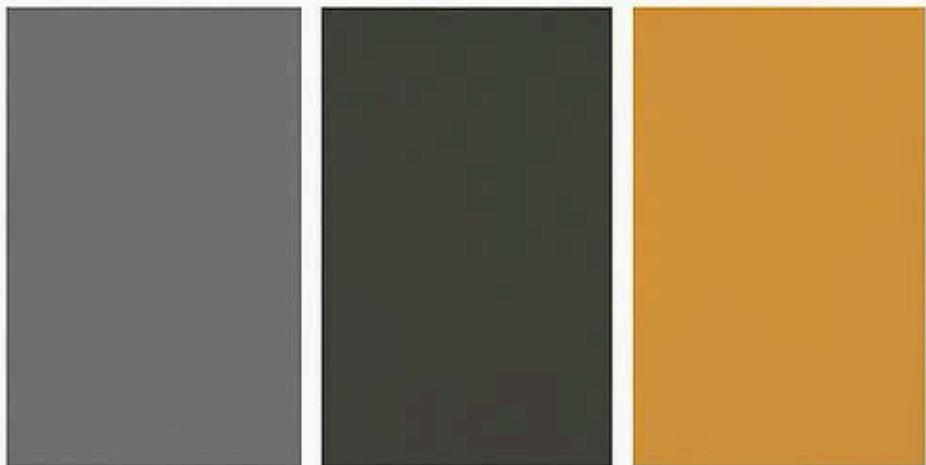


DEWALT Clip-On Wearable Speaker

Description: Lightweight clip-on design, IP56 water/dust resistance, and built-in mic for hands-free calls.
Relevance: Best for workers who need personal, mobile audio while moving around the site.



WOOD BOARD





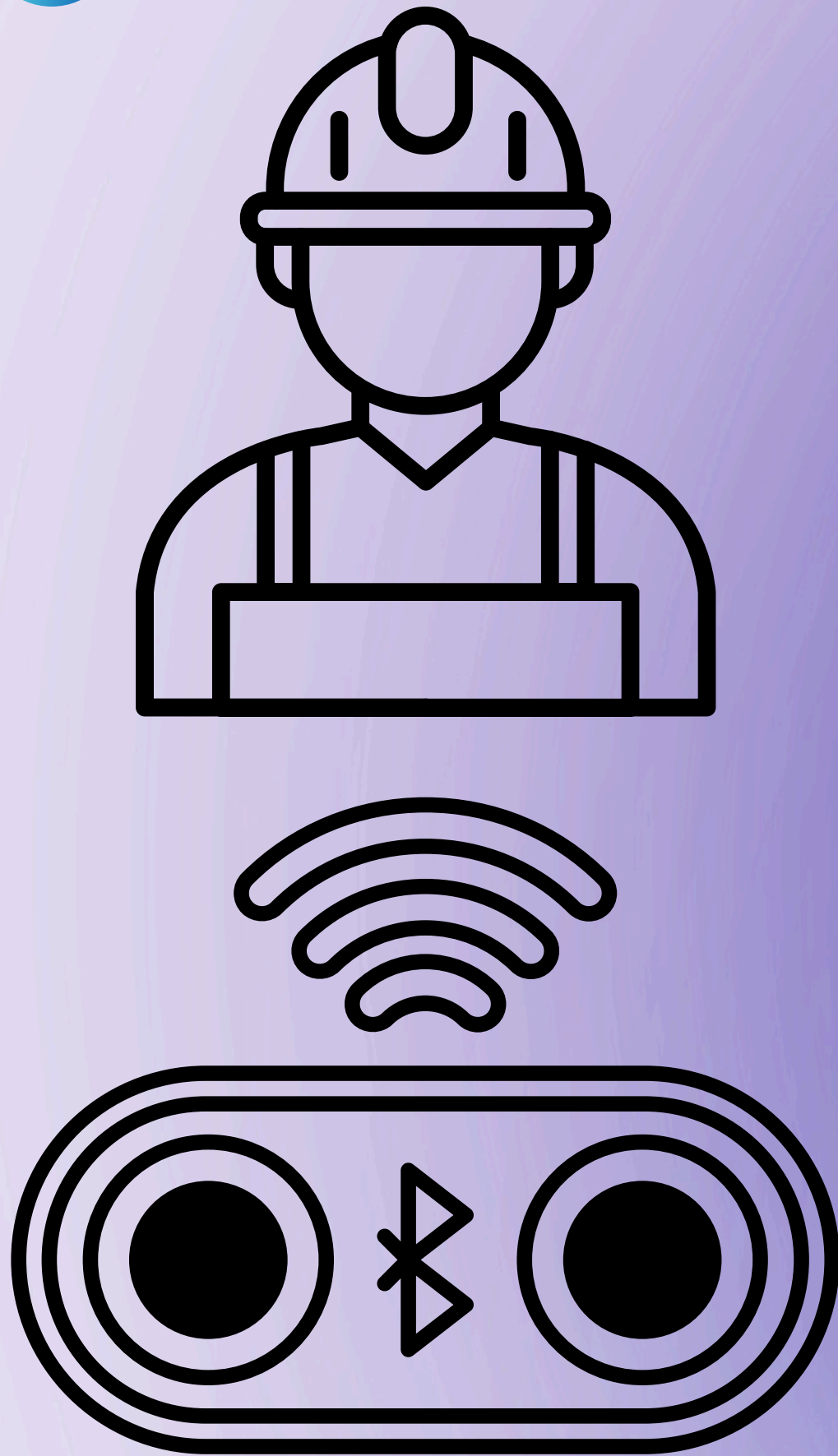
CONSTRUCTION AND MUSIC



Research shows that listening to music can enhance mood, improve work quality, and increase efficiency in task completion. A study by Lesiuk (2005) found that employees allowed to listen to music reported higher positive affect on their mental health, slightly better work quality, and reduced time on tasks. At the same time, removing music resulted in a lower mood and lower productivity. These findings suggest that music can serve as a mood regulator and a performance booster, particularly in a demanding or repetitive work environment.

Lesiuk, T. (2005). The effect of music listening on work performance. *Psychology of Music*, 33(2), 173-191.
<https://doi.org/10.1177/0305735605050650>

CONSTRUCTION AND MUSIC



Research suggests that music is an effective, non-invasive tool to help counteract mental fatigue and or sustain performance during certain prolonged tasks. A study by Ding et al. (2025) found that music interventions can help reduce subjective feelings of mental fatigue, help improve cognitive and behavioral performance, and enhance your mood, especially when a task is repetitive or mentally demanding. The study highlights that music regulates arousal, restores attention, and maintains motivation, which are critical in work settings that require sustained focus, such as construction sites.

Ding, C., Kim Geok, S., Sun, H., Roslan, S., Cao, S., & Zhao, Y. (2025). Does music counteract mental fatigue? A systematic review. PLOS ONE, 20(1), 1-20.
<https://doi.org/10.1371/journal.pone.0316252>



PHASE 2

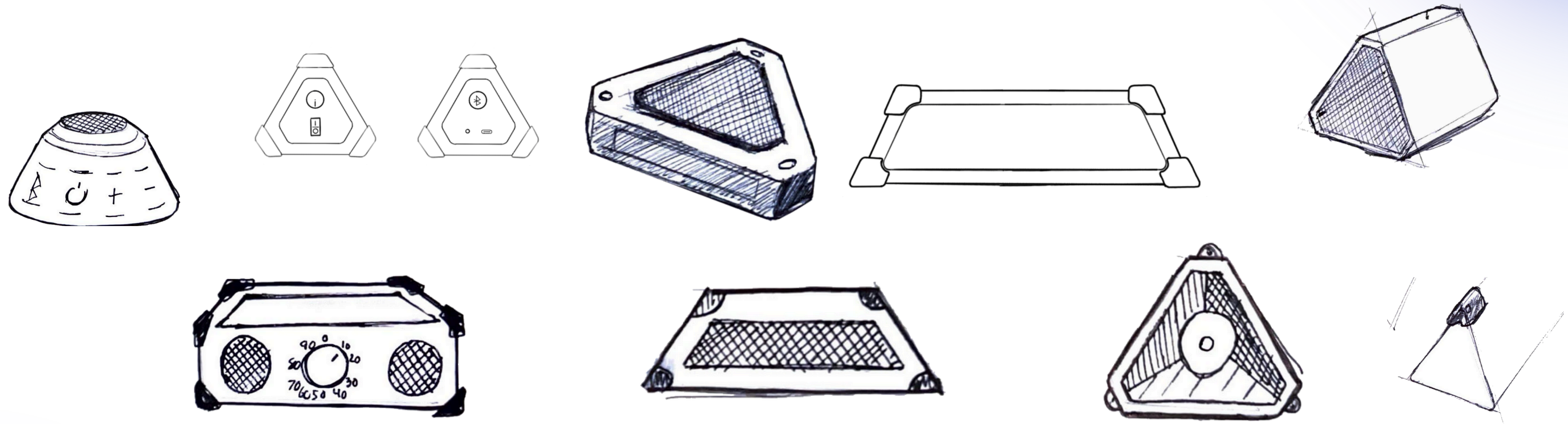
In Phase 2, we went from studying parts to making ideas. We used what we learned from taking things apart and talking to users to create new product concepts. Our focus is on construction workers who need speakers that are strong, easy to carry, and easy to use with gloves.



With a chosen
demographic, and
research we started to
ideate what the product
would look like and the
features it would contain



DESIGN CRITERIA AND IDEATION



DURABILITY

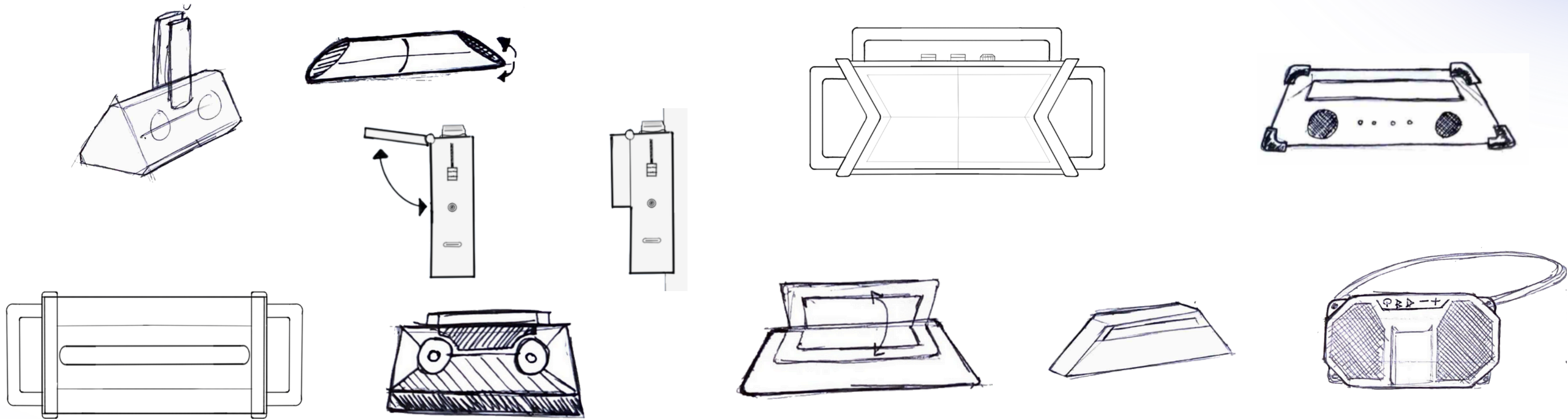
Insight: Insight: Devices get dropped, scratched, or exposed to rain

Response: Rubber Contact Points on all major corners to absorb hits, as well as a waterproof shell

Insight: Dust and mud easily clog or damage electronics.

Design Response: Easy-to-clean speaker grille, dust-proof mesh, and sealed port covers.

DESIGN CRITERIA AND IDEATION



MOBILITY

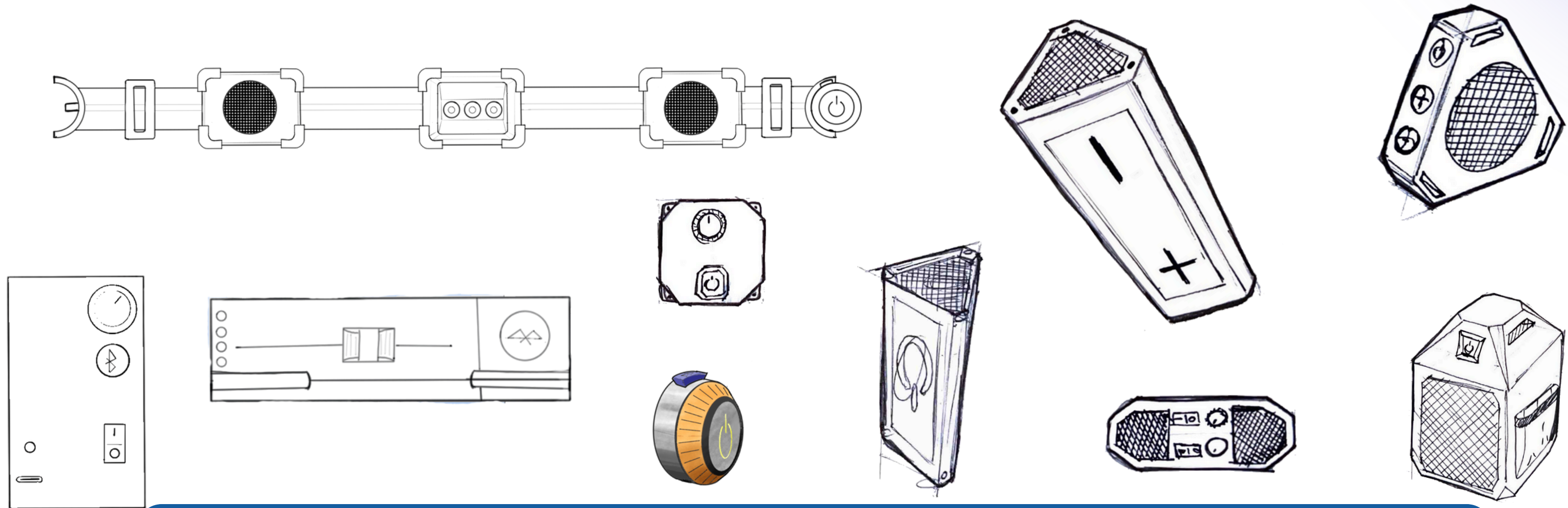
Not extremely heavy and easy to carry around the job site

Insight: Workers move frequently between areas.

Design Response: Integrated strap, clamp, and magnetic mounting for flexible placement. Features can double as a grabbing point or a handle



DESIGN CRITERIA AND IDEATION



USABILITY

Insight: Construction workers wear gloves and don't have time for delicate controls.

Design Response: Large flip switches and dials with tactile feedback, operable with gloves on

Insight: Workers value speed and reliability over complex features.

Design Response: Simplified interface with dedicated switches for power, Bluetooth, and volume.

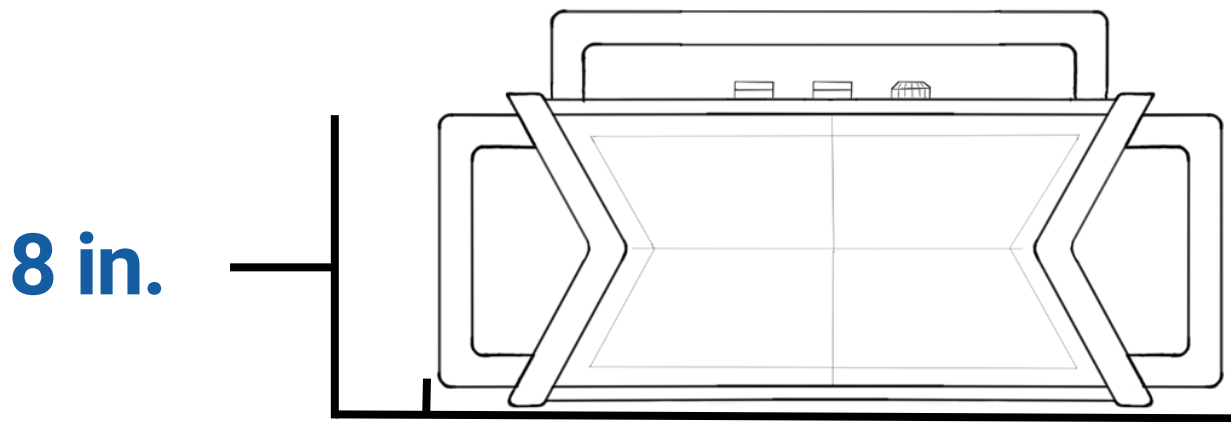
Insight: Job sites are loud (saws, drills, heavy machinery).

Design Response: High-output drivers and clear sound tuning that cuts through background noise.

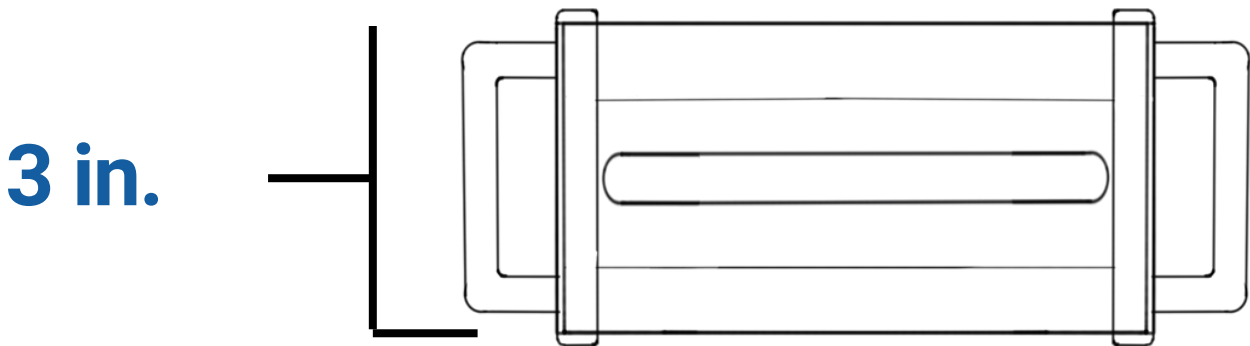


IDEATION

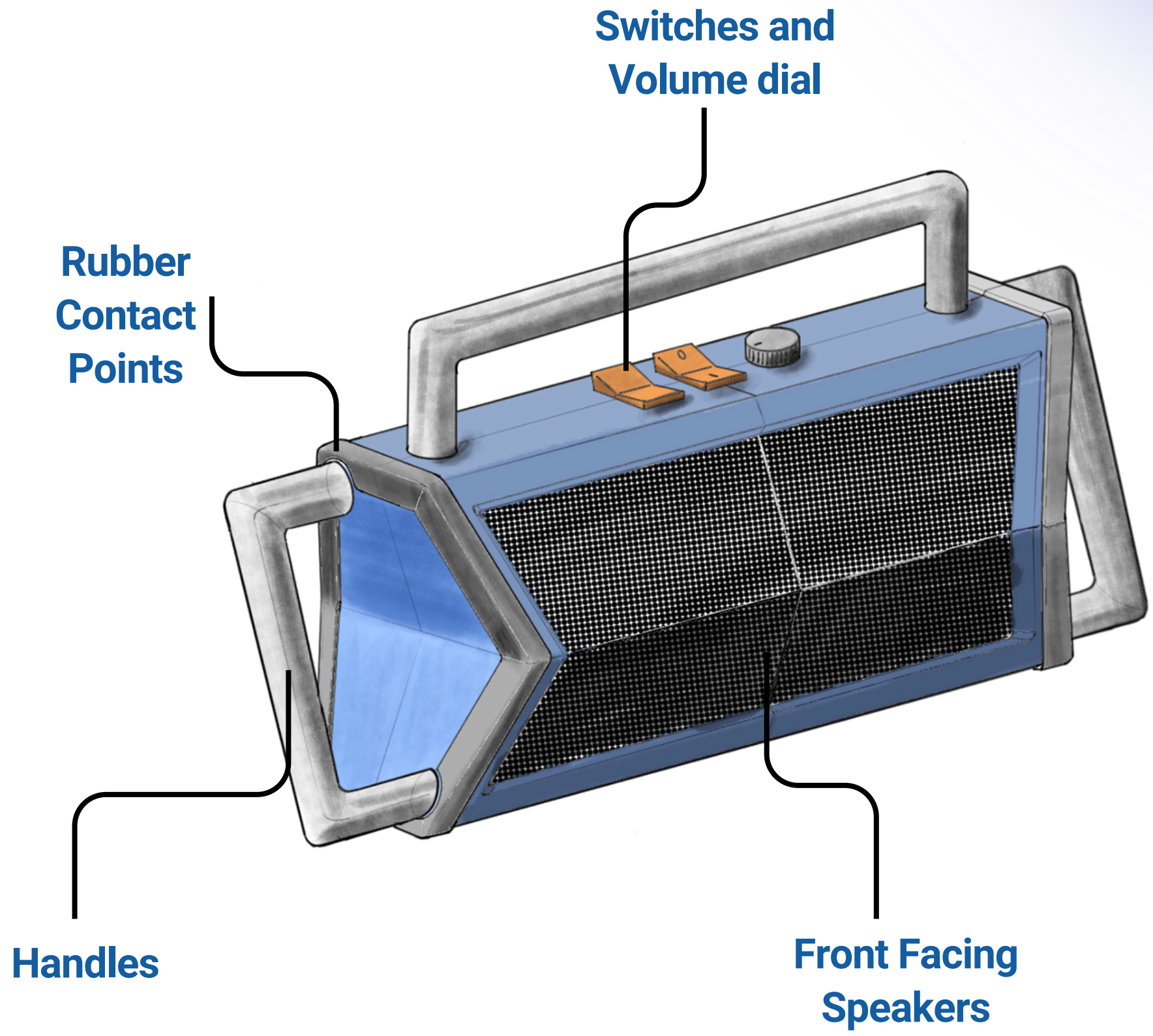
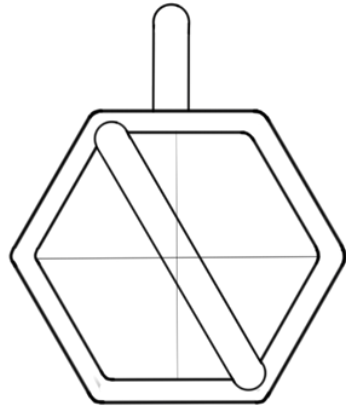
FRONT



TOP



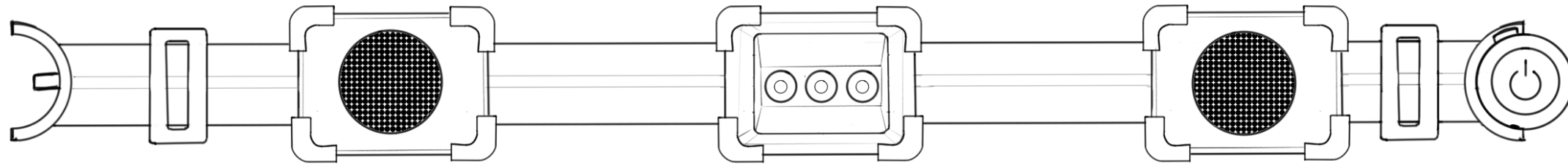
SIDE





IDEATION

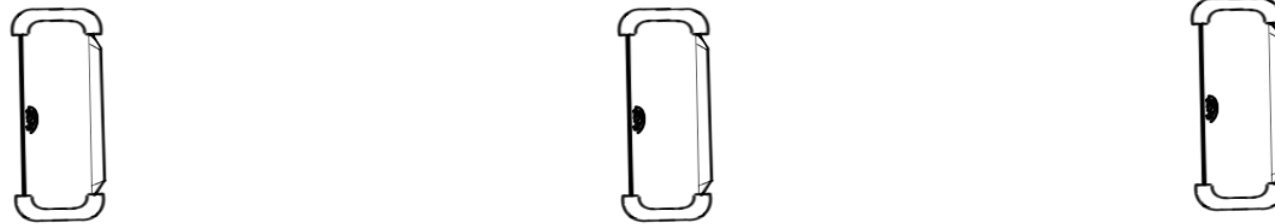
FRONT



TOP



SIDE



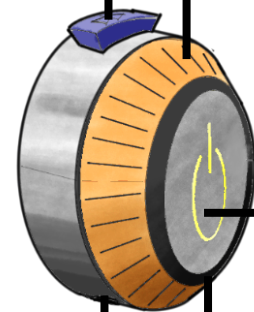
Bluetooth

Volume Dial

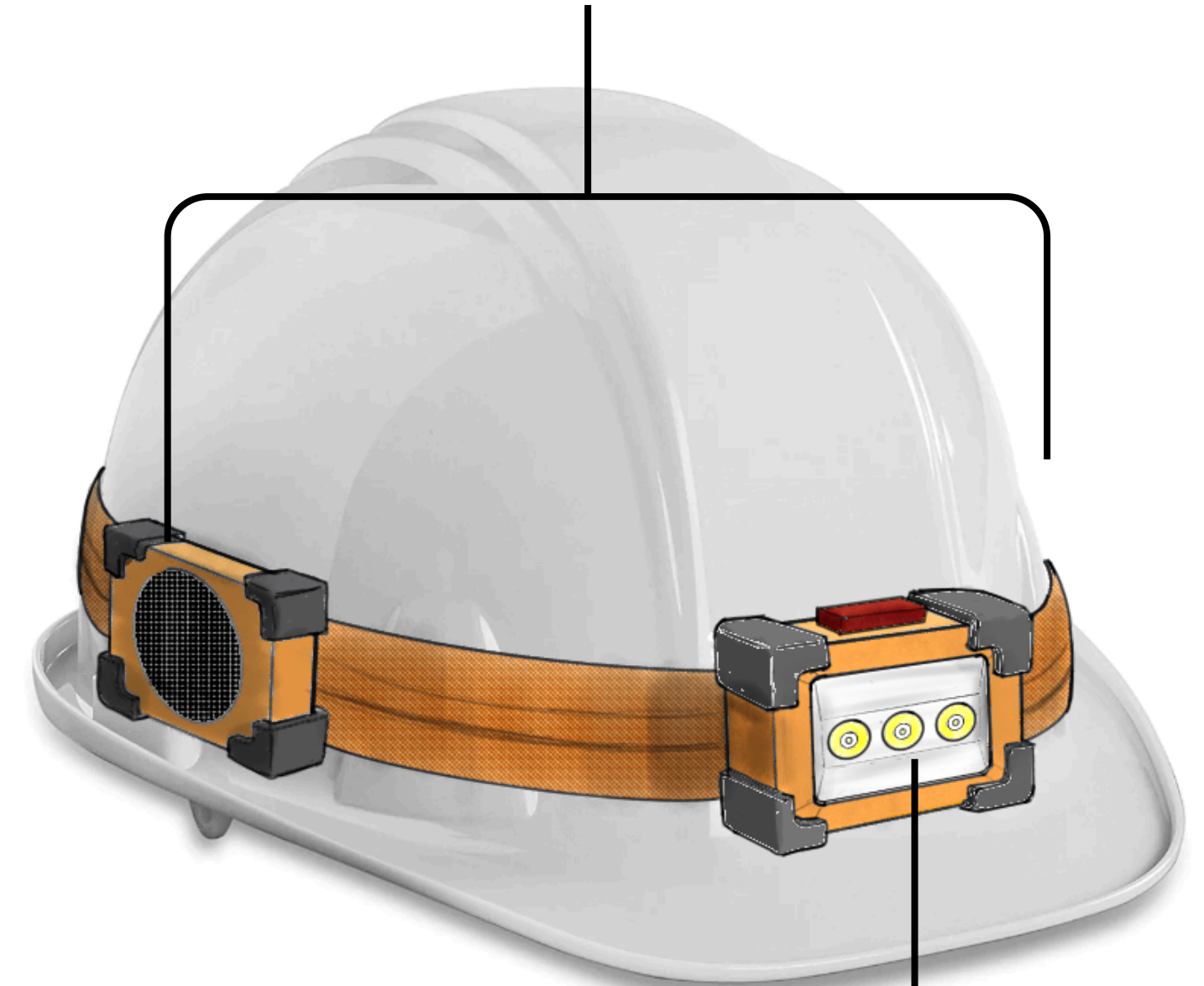
Power
Button/Battery
Light

USB-C &
AUX

Goes on back of
helmet or head



Speakers
over both
ears



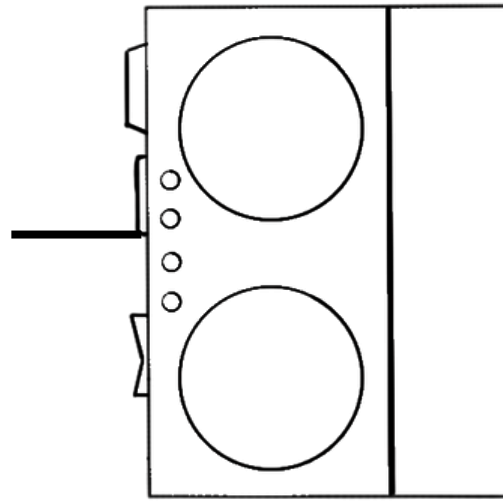
Head lamp
with power
button



IDEATION

FRONT

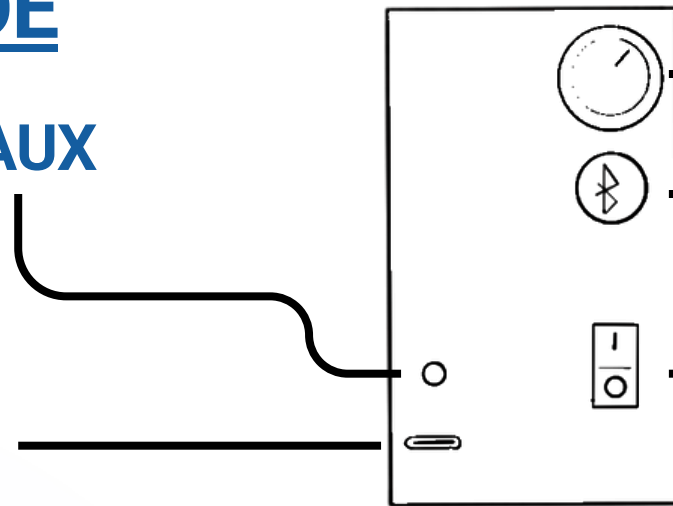
Battery Lights



SIDE

AUX

USB-C

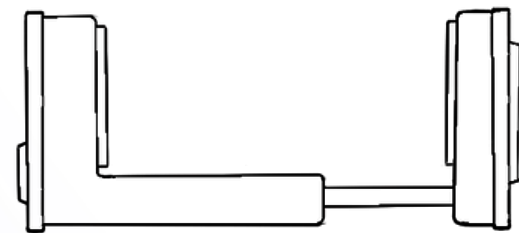


Volume Dial

Bluetooth

Power
Button

TOP



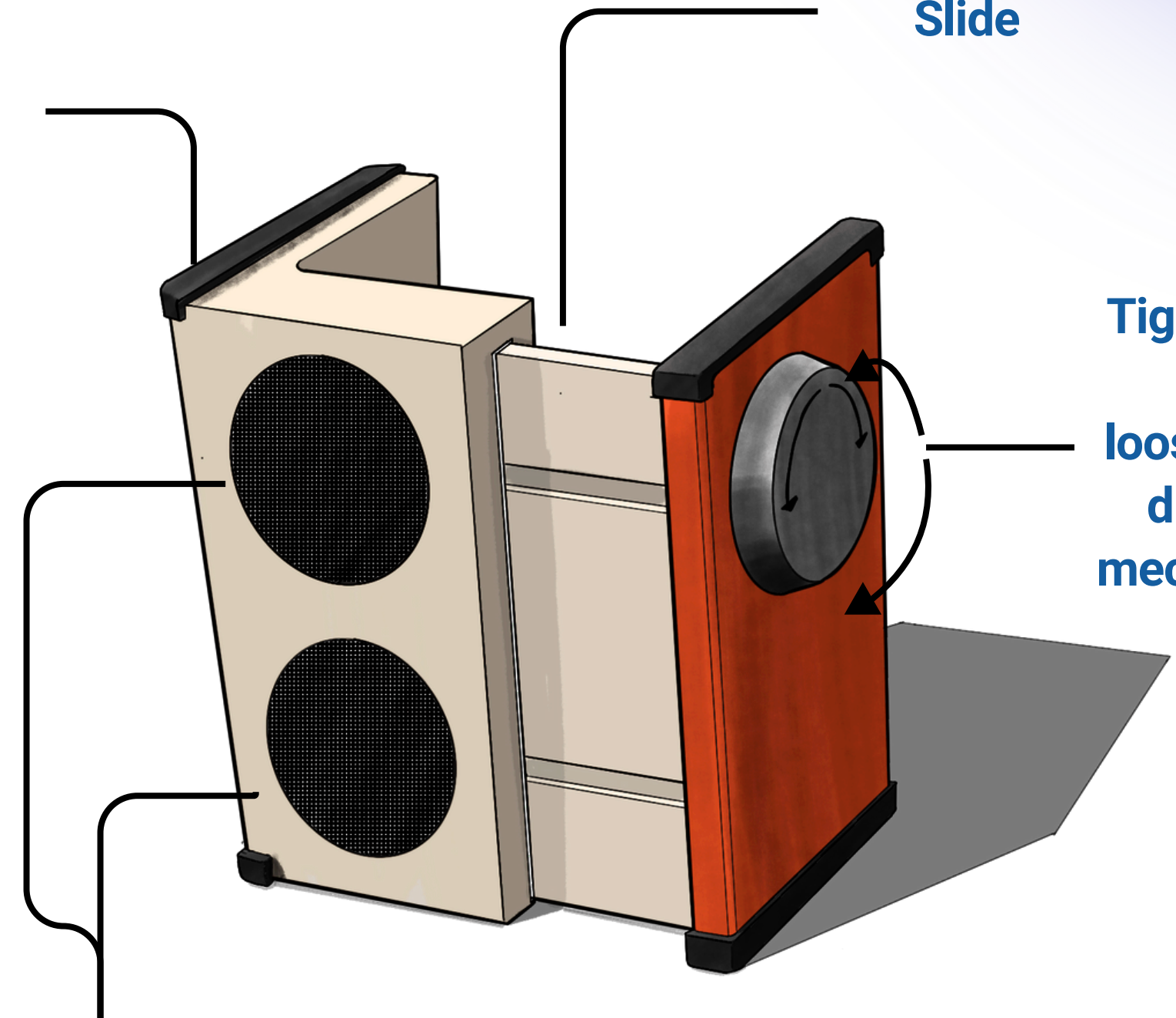
Adjustable for pillars or other
surfaces

Rubber
Contact
Points

Adjustable
Slide

Tightening
and
looseening
dial for
mechanism

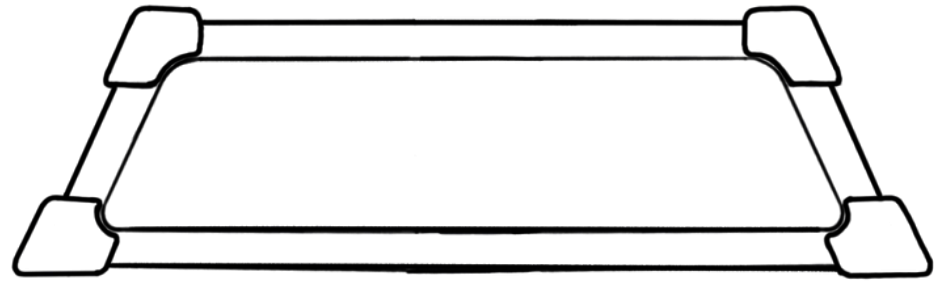
Front Facing
Speakers



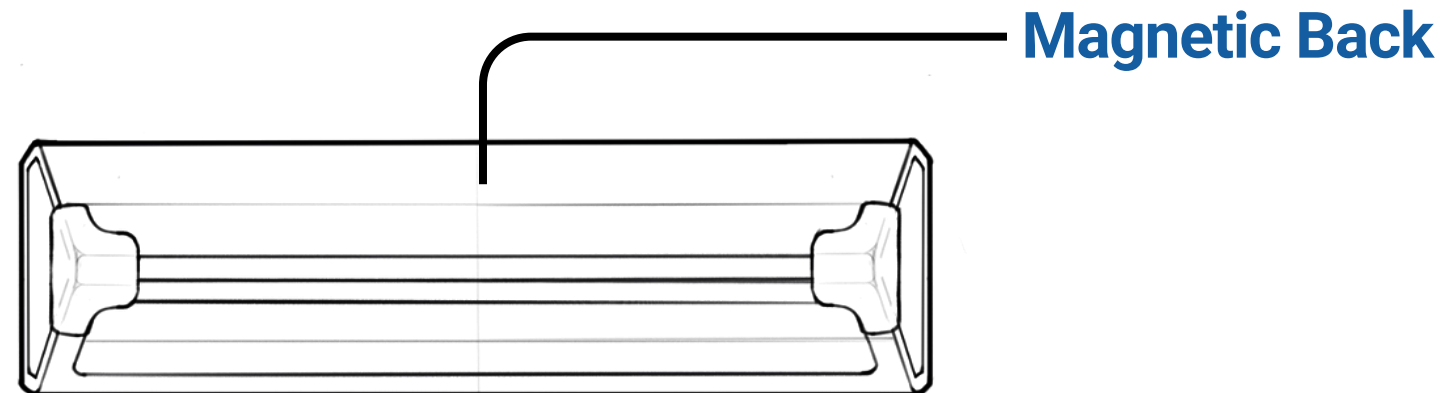


IDEATION

FRONT



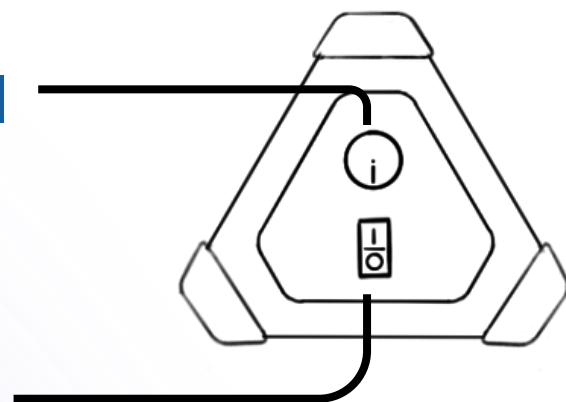
TOP



Magnetic Back

SIDE

Volume Dial

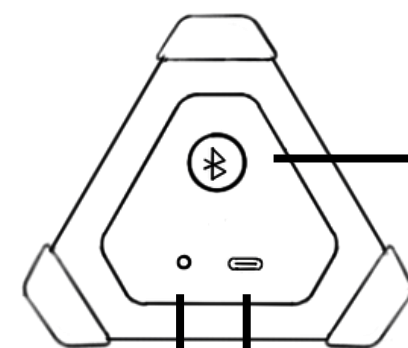


Power Button



AUX

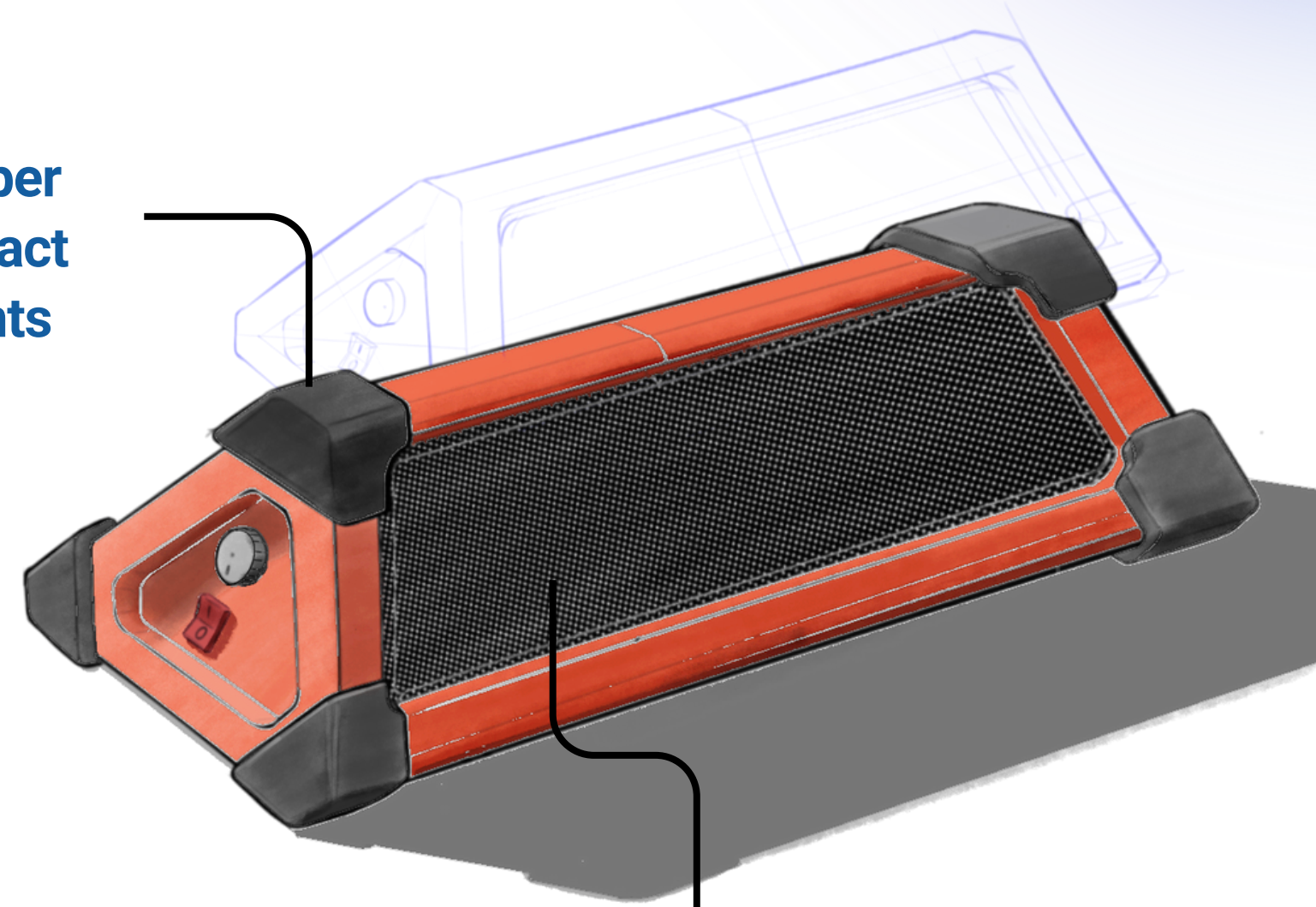
USB-C



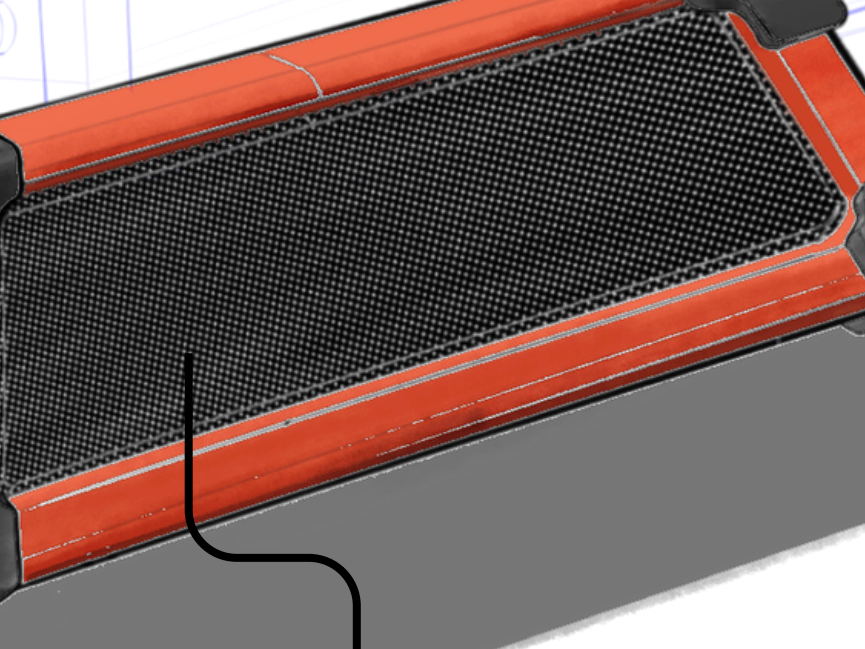
Bluetooth



Rubber Contact Points

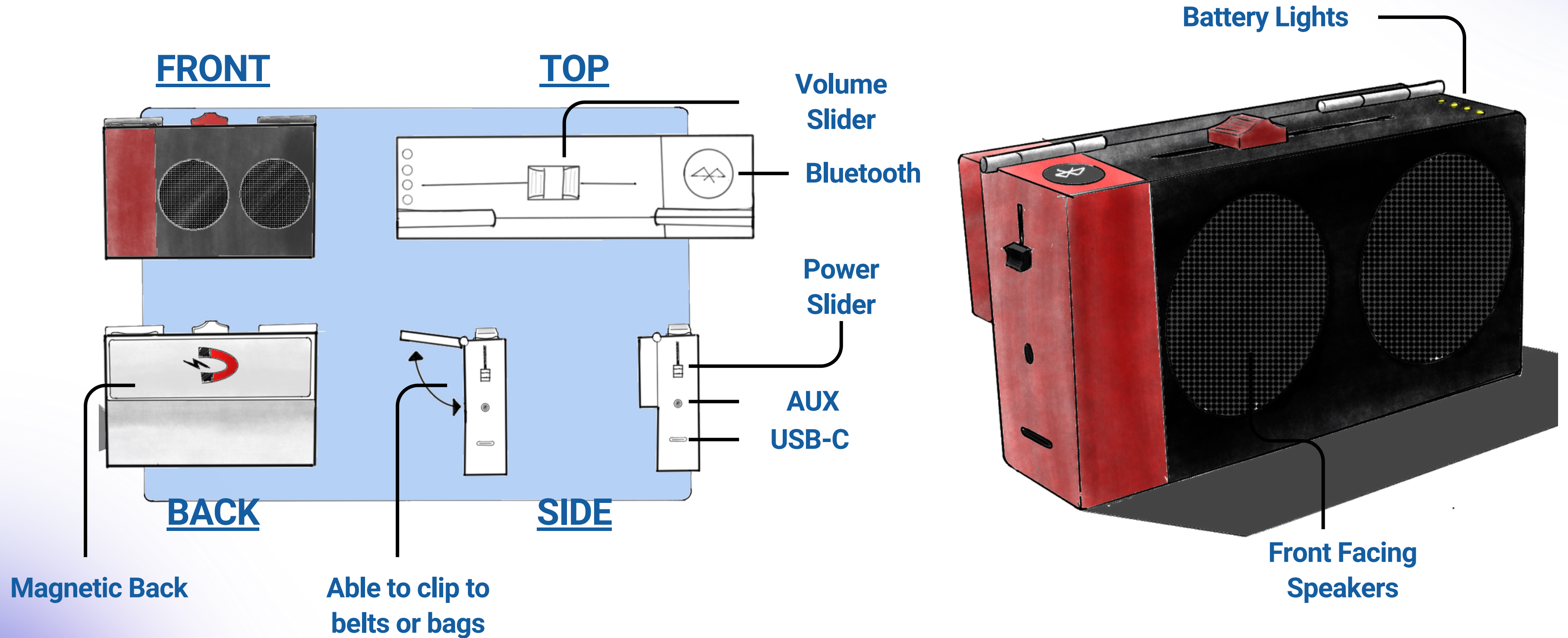


Front Facing Speakers





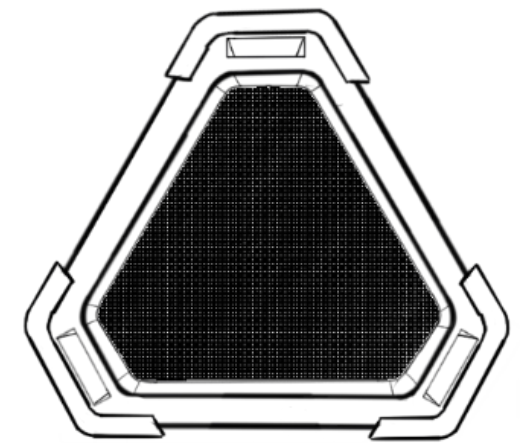
IDEATION



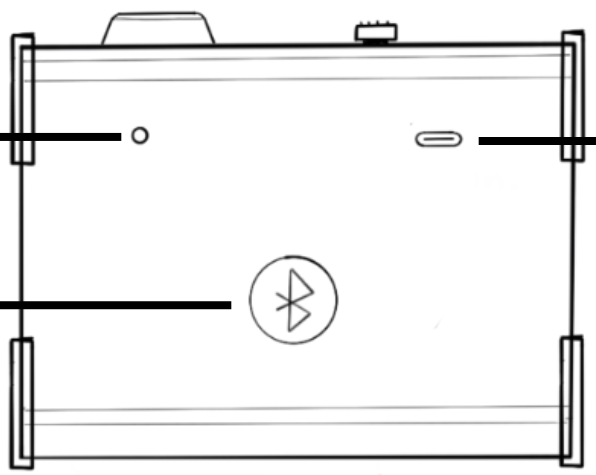


IDEATION

FRONT



SIDE

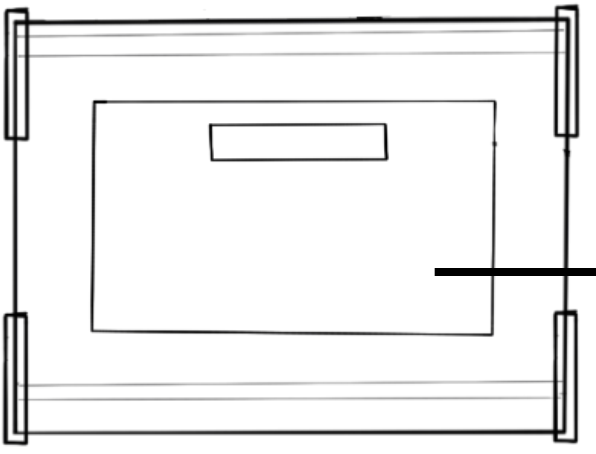


AUX

Bluetooth

USB-C

SIDE



Small
Compartment

Volume Dial

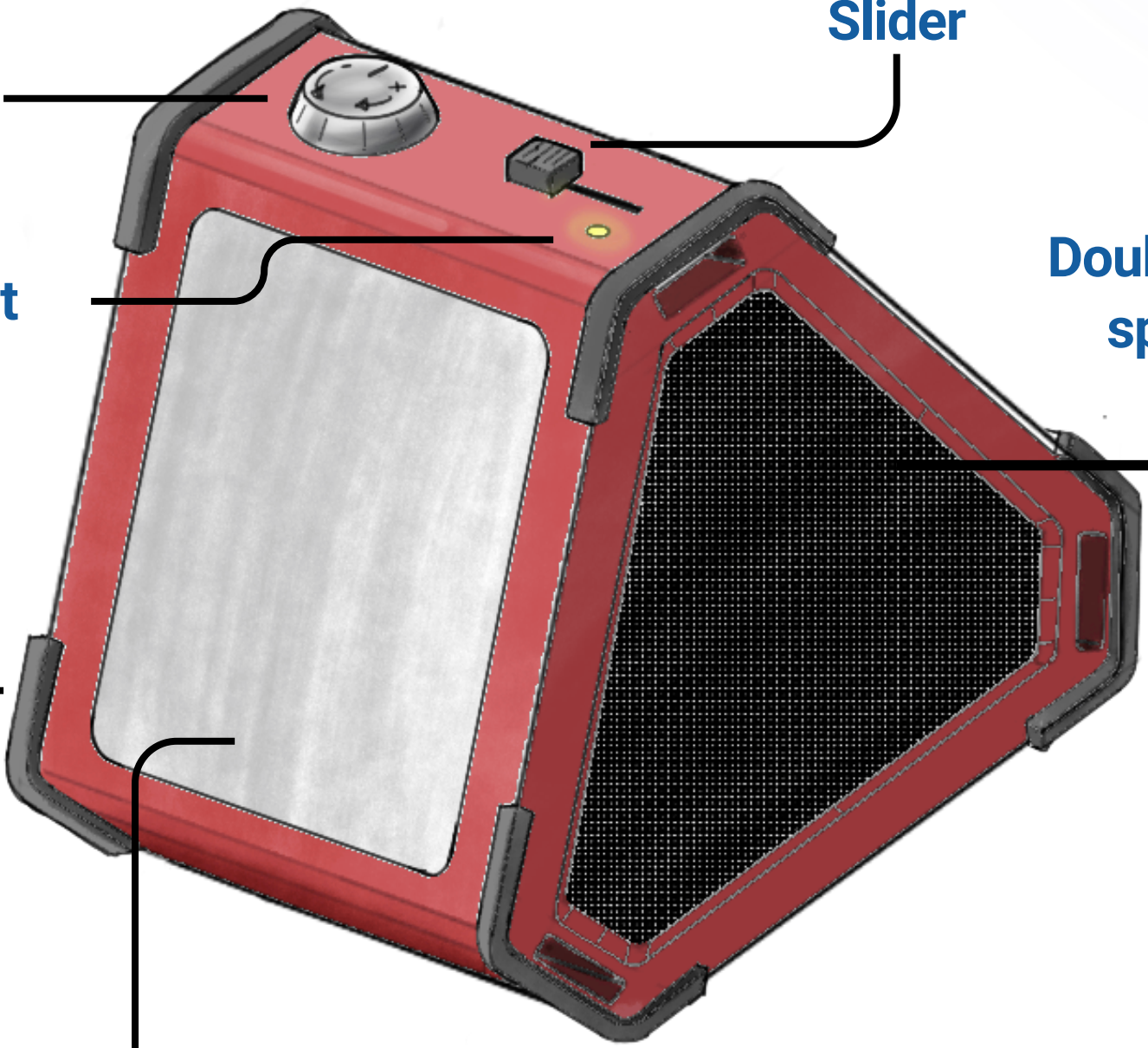
Battery Light

Rubber
Contact
Points

Magnetic Back

Power
Slider

Double sided
speaker





MODELS

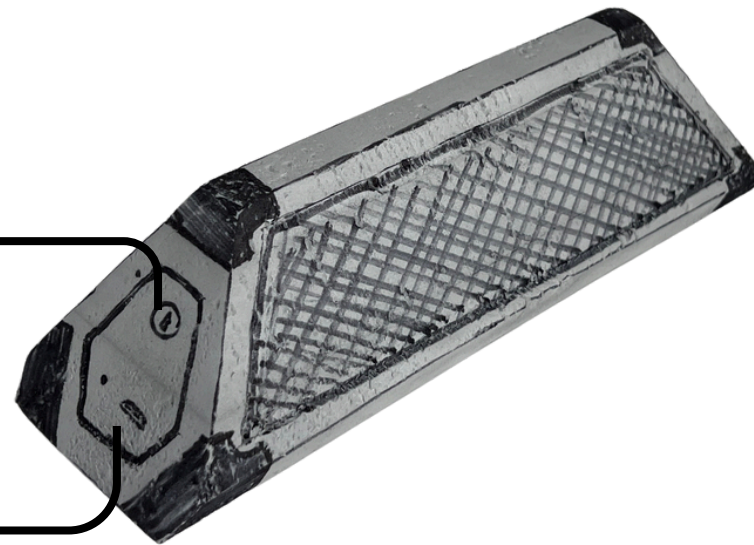
Durability



- Key Features:**
- Magnetic Back
 - Durable Body
 - Easy to reach Buttons
- Areas for improvement:**
- Overall mobility
 - Better speaker placement
 - Overall Shape

Volume Dial

Power Button

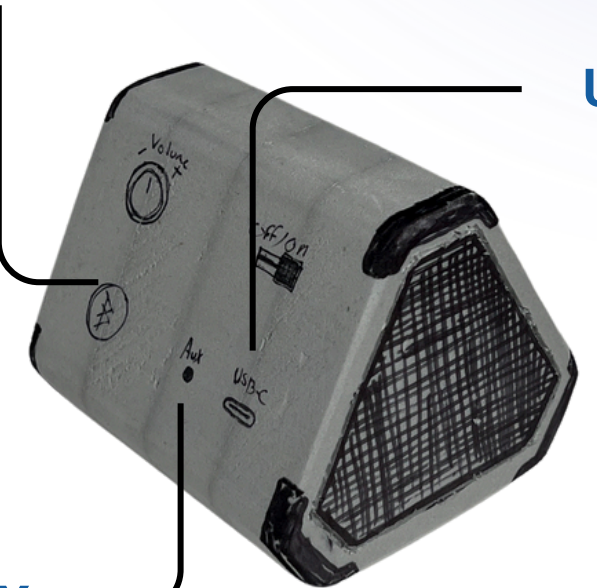


- Key Features:**
- Magnetic Back
 - Small Size
 - Ease of mobility
- Areas for improvement:**
- Speakers could be angled better
 - Bland Looks
 - Overall shape

Bluetooth

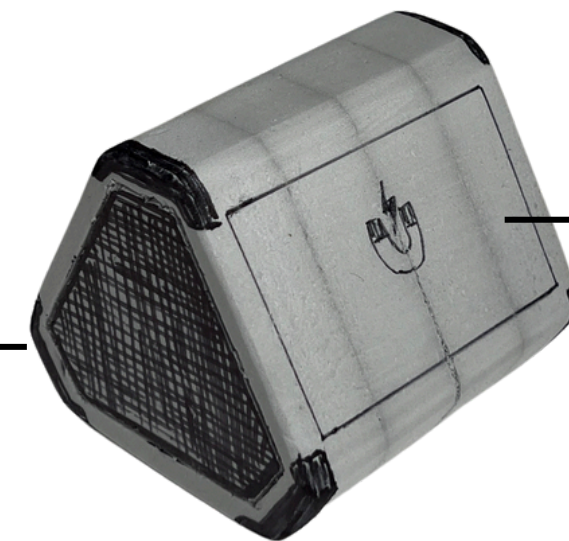
USB-C

AUX



Rubber Contact Points

Magnetic Back





MODELS

Usability

Volume
Slider



Key Features:

- Small Size
- Can use buttons without looking
- Can be on person or off person

Areas for improvement:

- Low durability
- Could work on the clipping system
- Small room for speaker
- Bad audio Directionality

Clips into belt
or tool bag

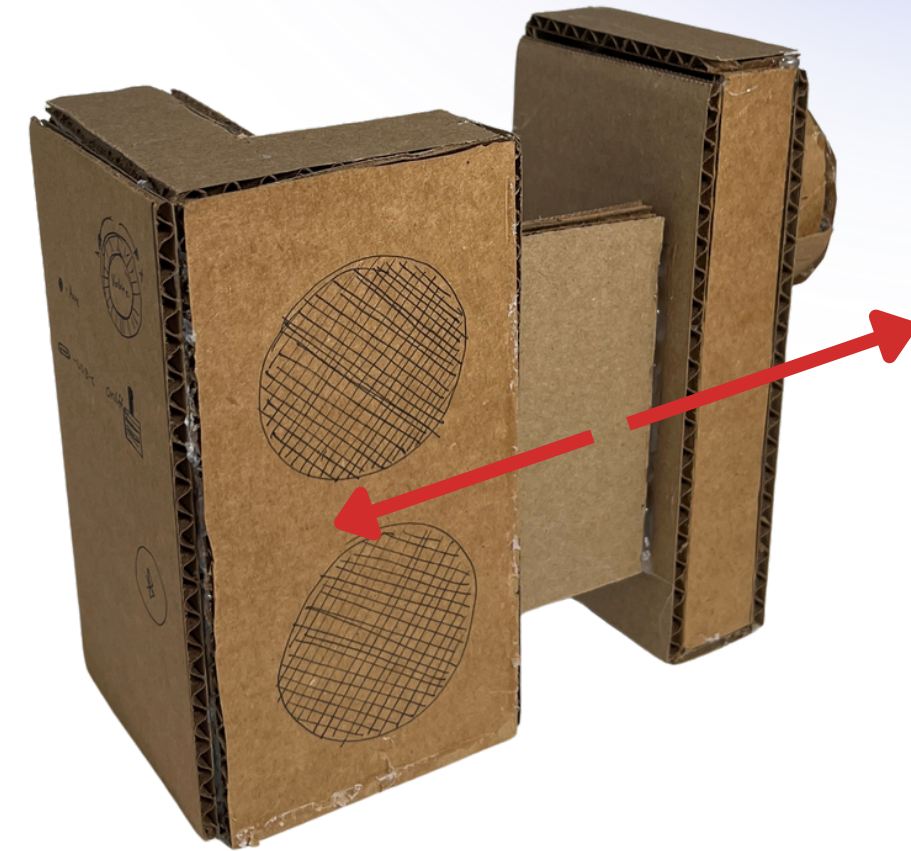


Key Features:

- Squeezing pillar mount
- Volume dial and power switch
- Small Size

Areas for improvement:

- Awkward shape
- Not very durable



Able to squeeze on pillars
so that it can be mounted
and out of the way



MODELS

Key Features:

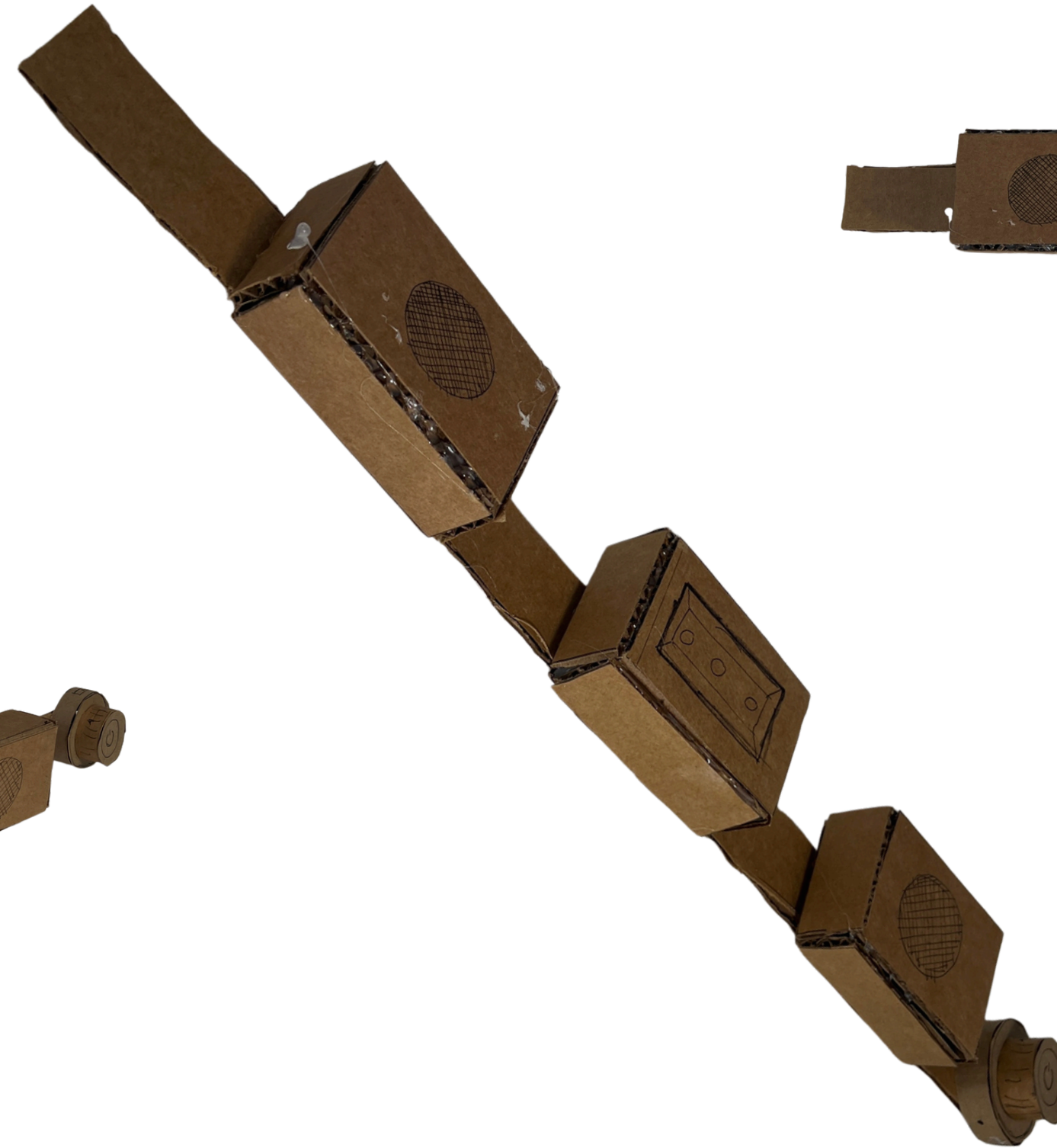
- Wearable on hardhat
- Easy to store not very heavy
- Headlamp
- easy clip in

Areas for improvement:

- Speakers are above ears
- Size



Head lamp
with power
button



Speakers over both
ears

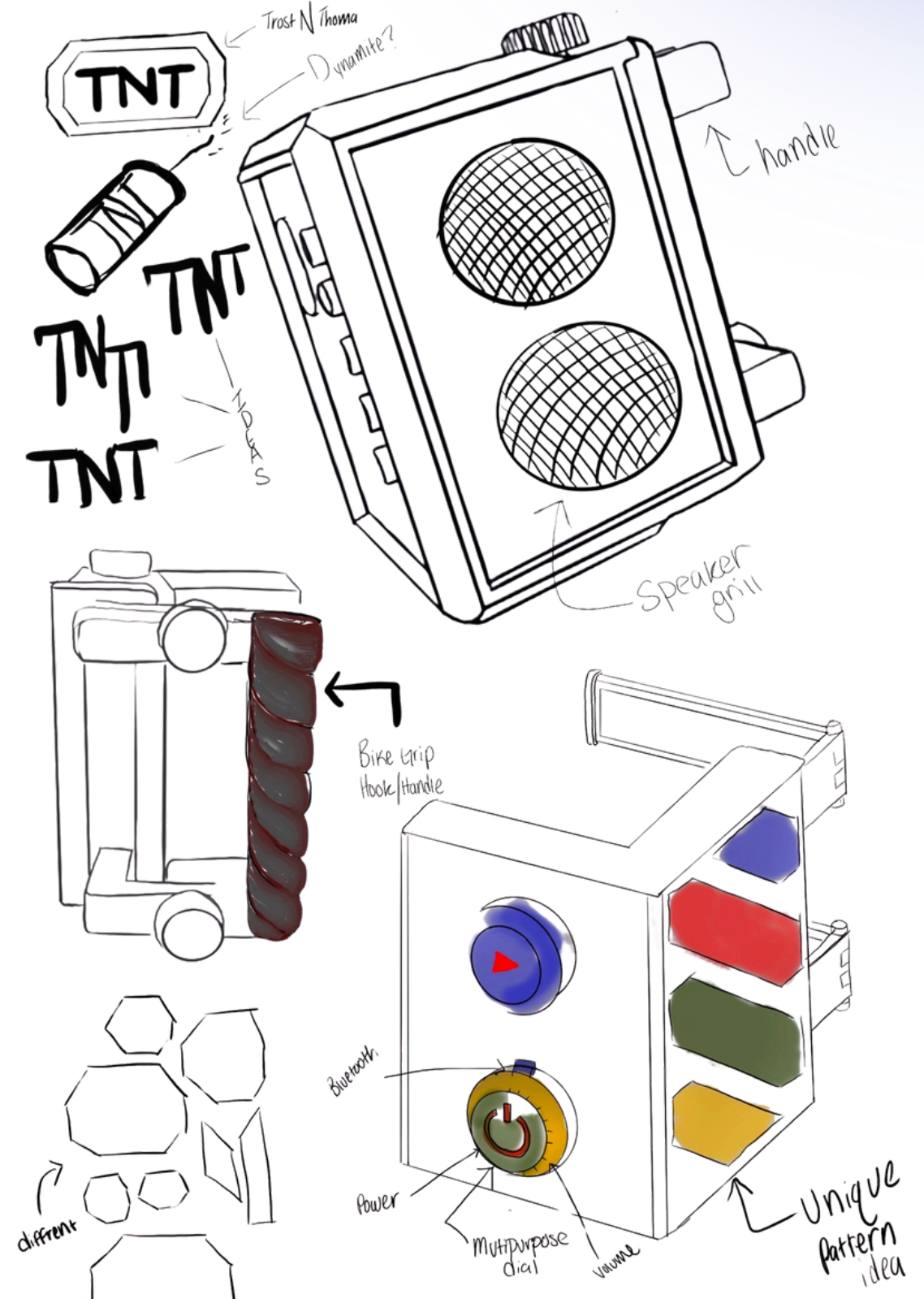
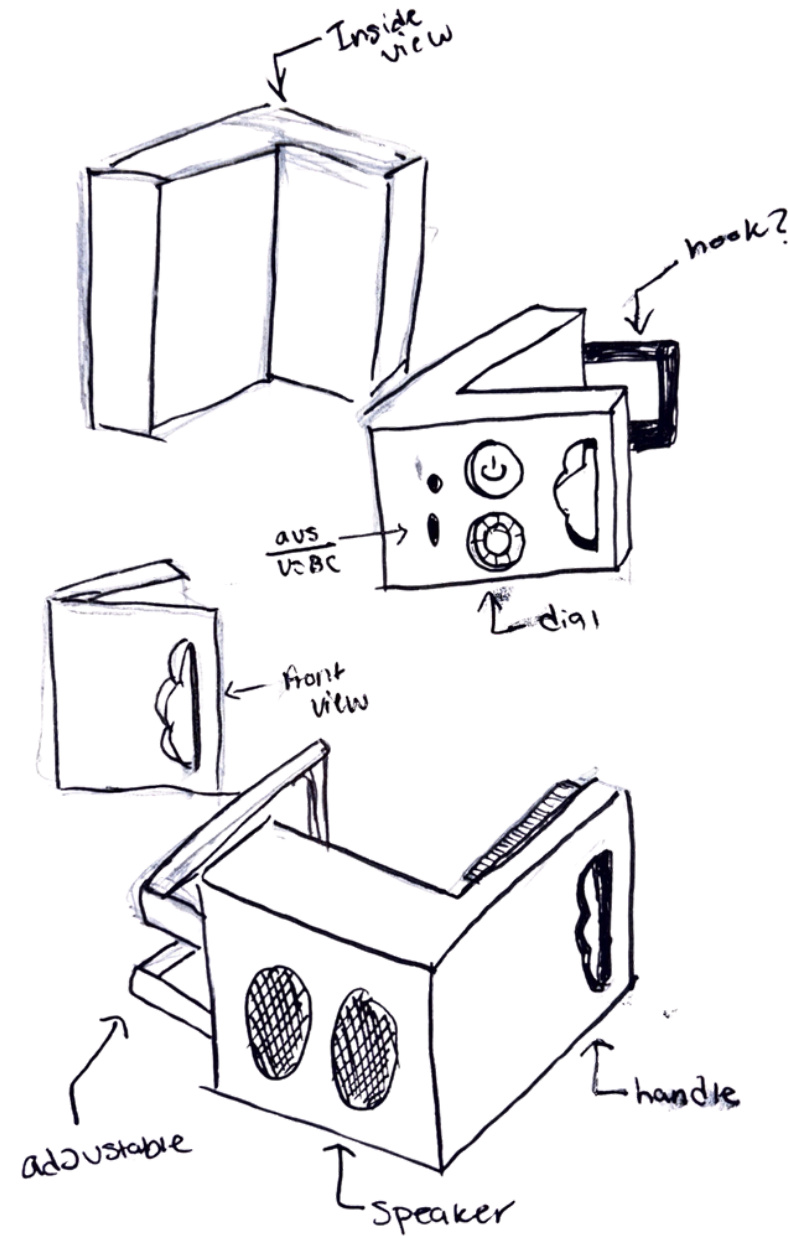
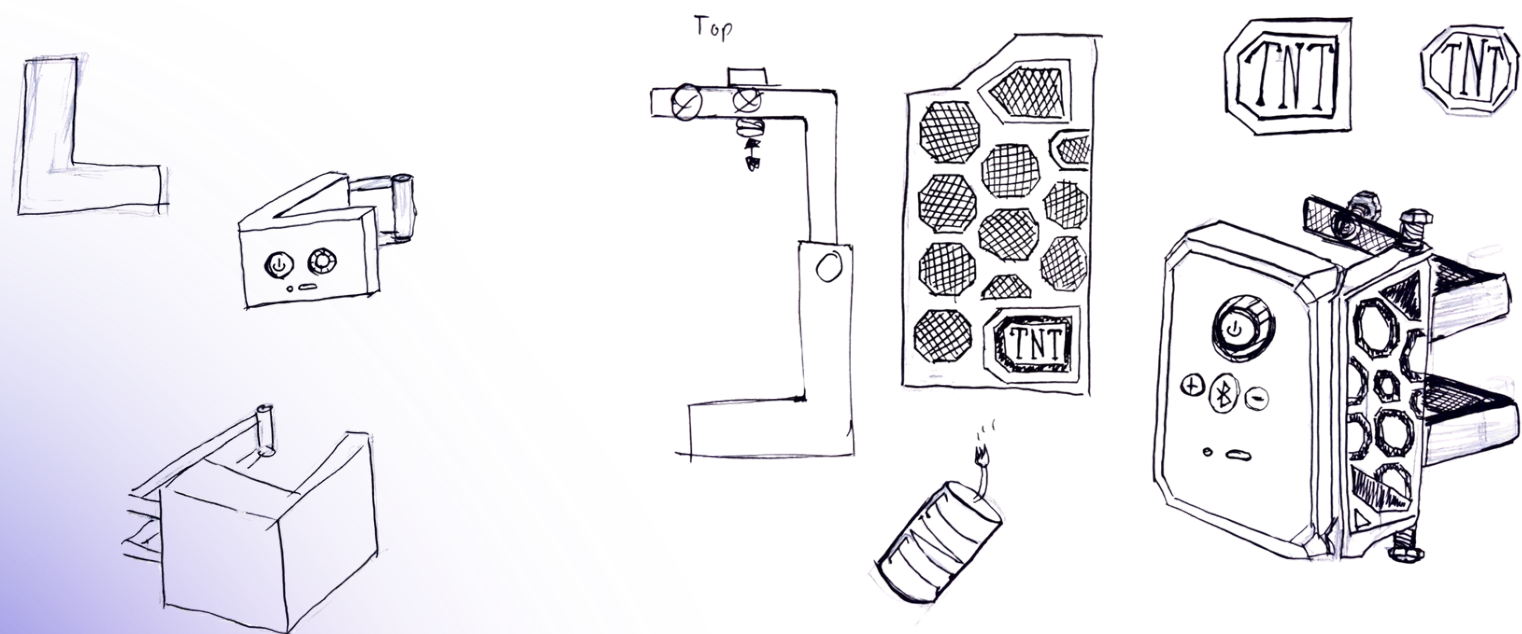
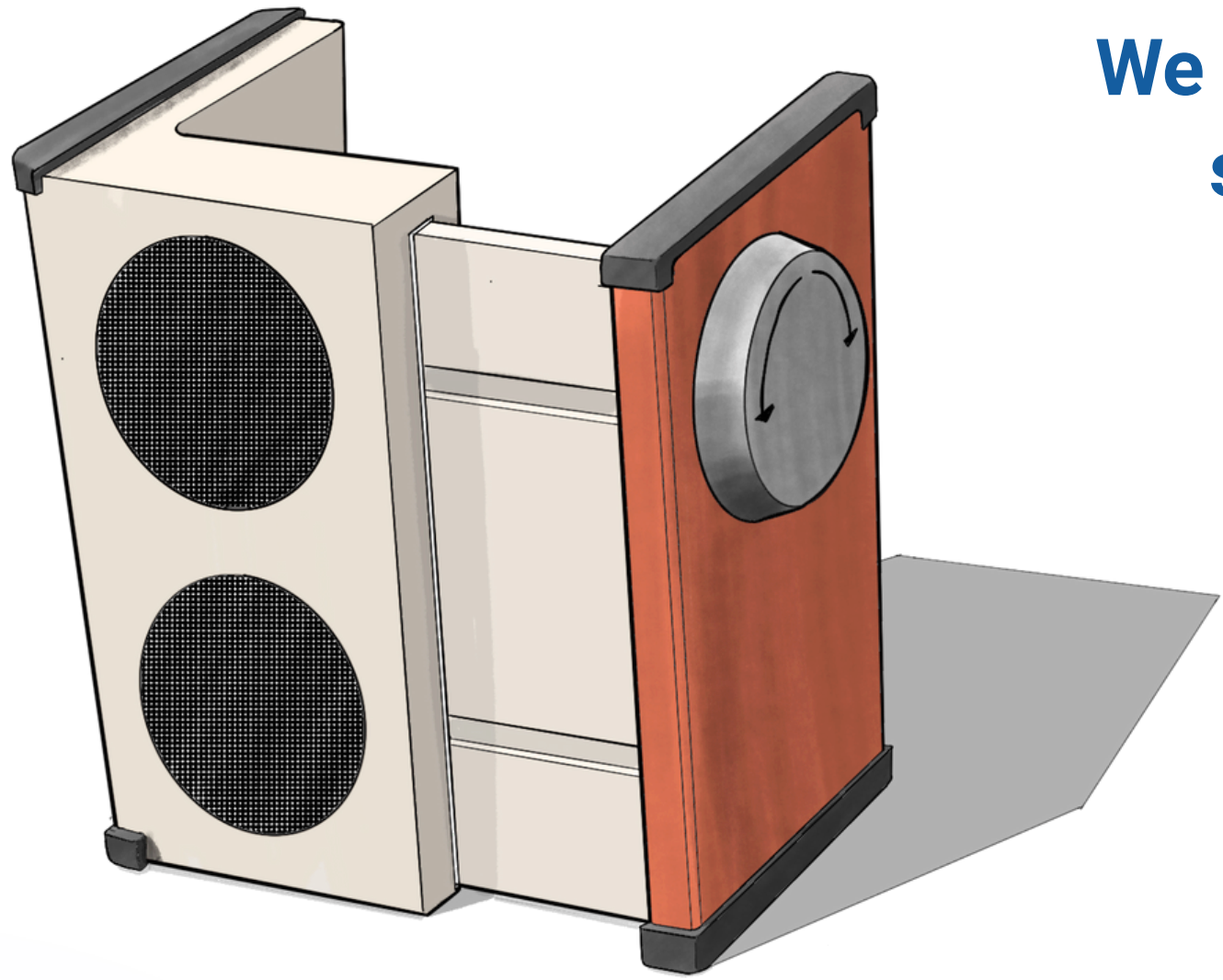
PHASE 3

In Phase 3, we build a fully functional prototype of our redesigned Bluetooth speaker. Using the original components, we create a compact and durable housing that reflects our user research while ensuring smooth usability, intuitive interactions, and strong assembly quality. Attention to CMF-T guides our choices in color, materials, and finishes, helping the prototype feel both practical and commercially ready.



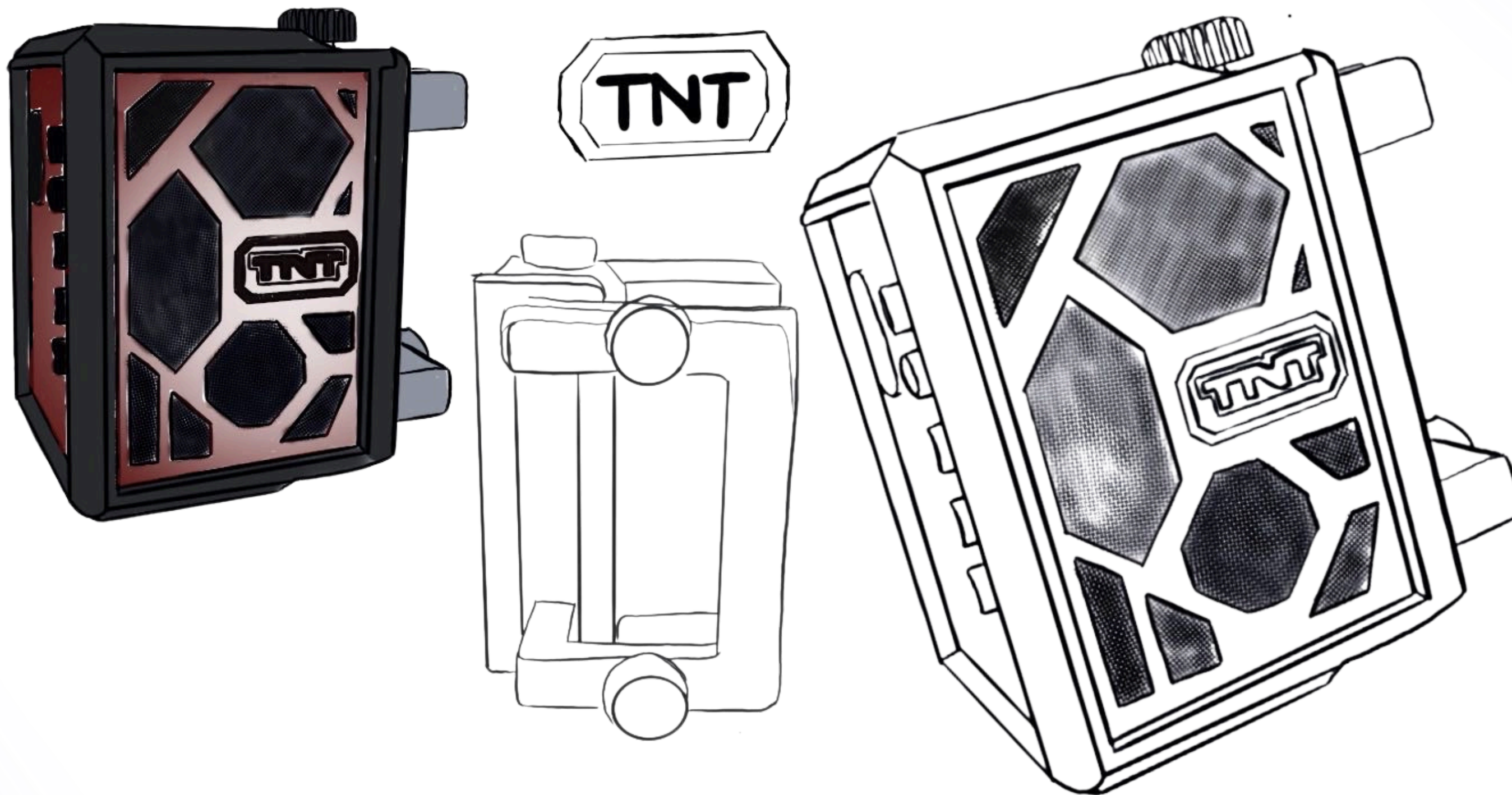
FINAL CONCEPT IDEATION

We chose to go with the clamping speaker as our final design





FINAL CONCEPT SKETCHES





FINAL MODEL



Covered
USB-C/AUX

Speaker grill and
internals cover

Easy to Access
buttons compatible
with gloves

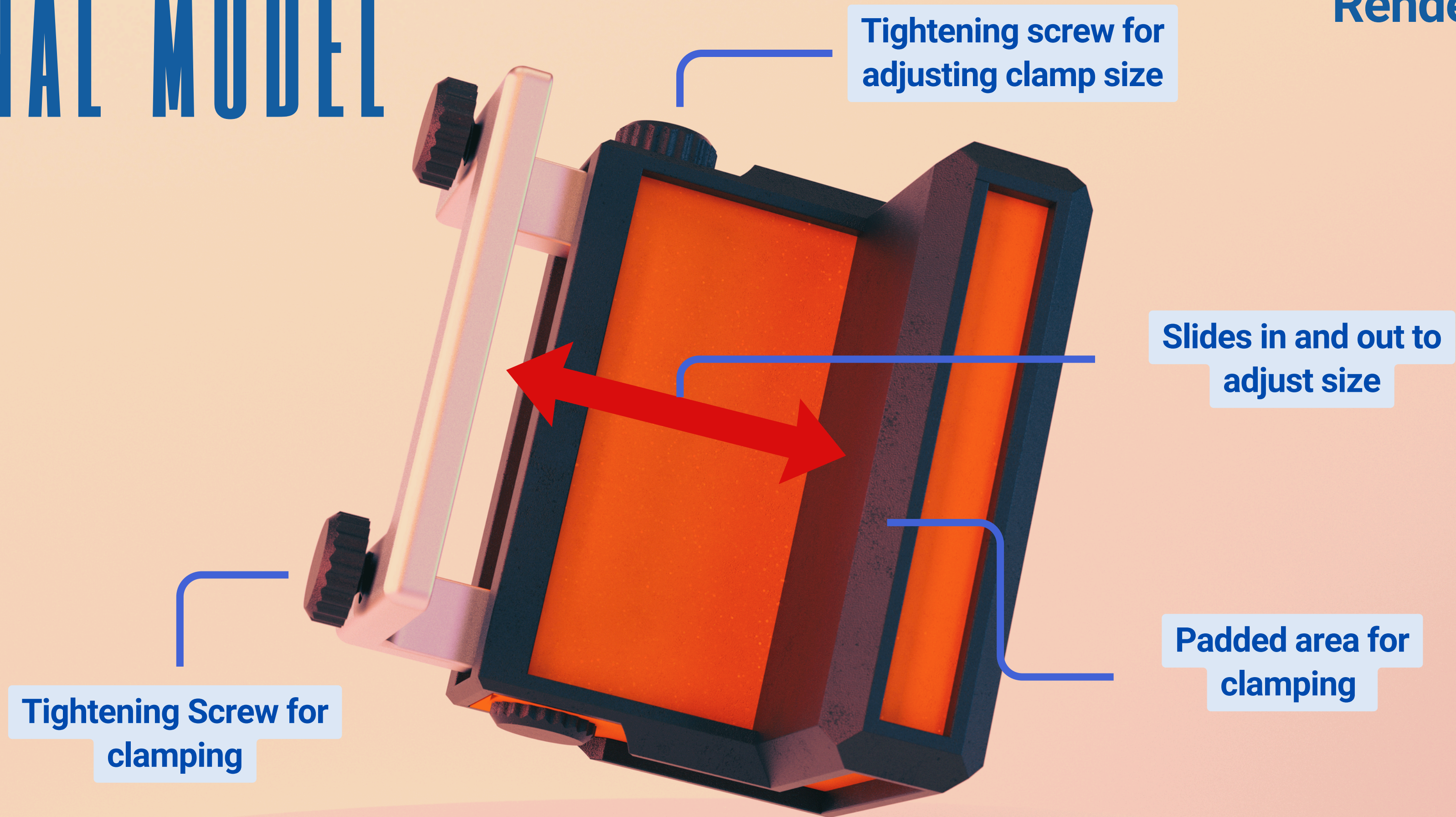
Hard outer shell
protecting corners
and internals



Render

FINAL MODEL

Render





FINAL MODEL



Simple Buttons
Power
Bluetooth
Pause/Play
Volume Up
Volume Down

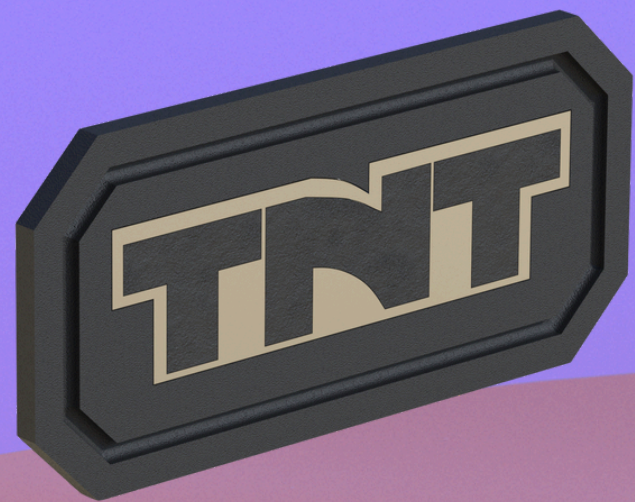
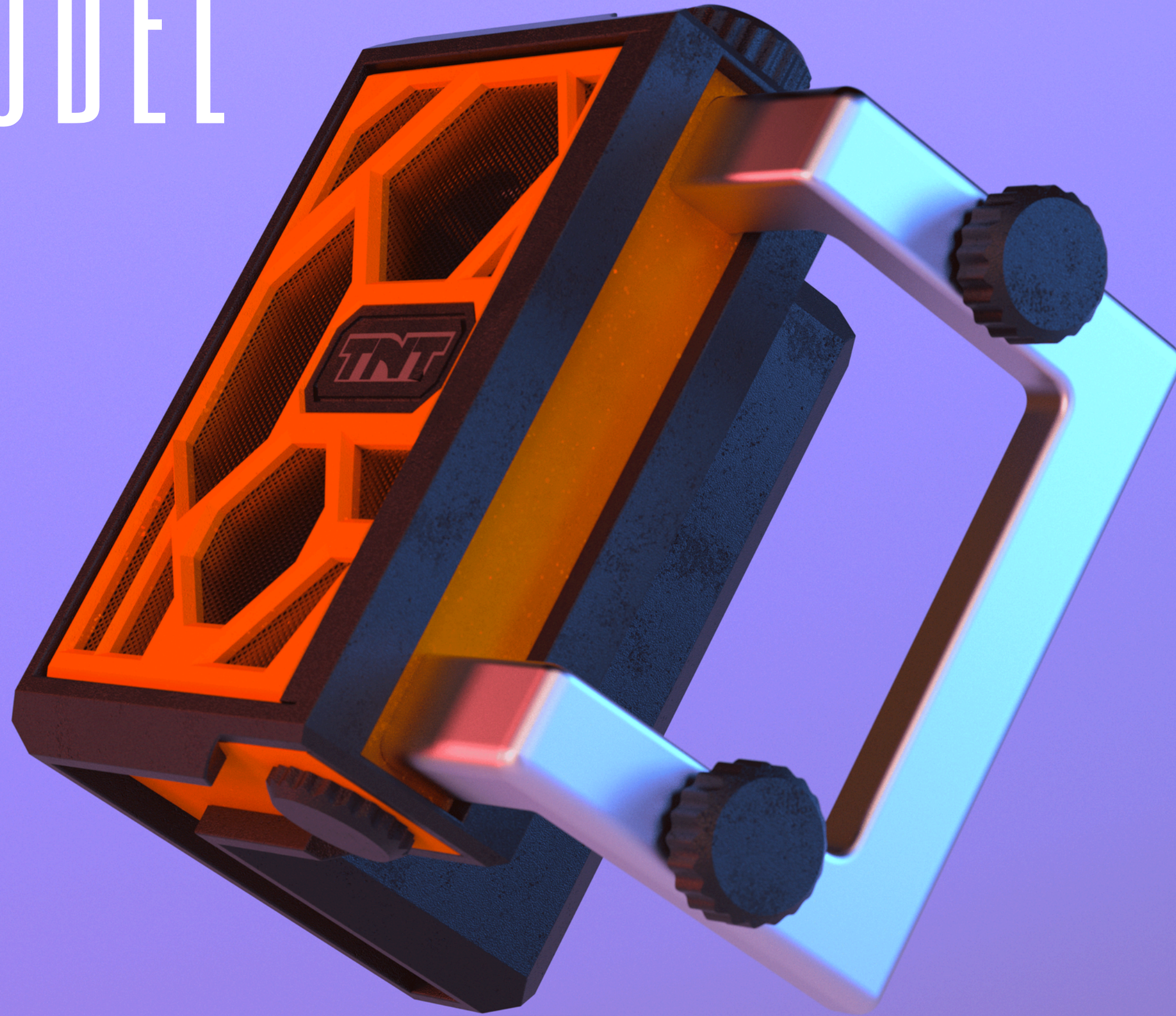
In Context Render

Easily clamps on posts to
keep speaker off jobsite
ground and easier to reach



FINAL MODEL

Render



FINAL MODEL



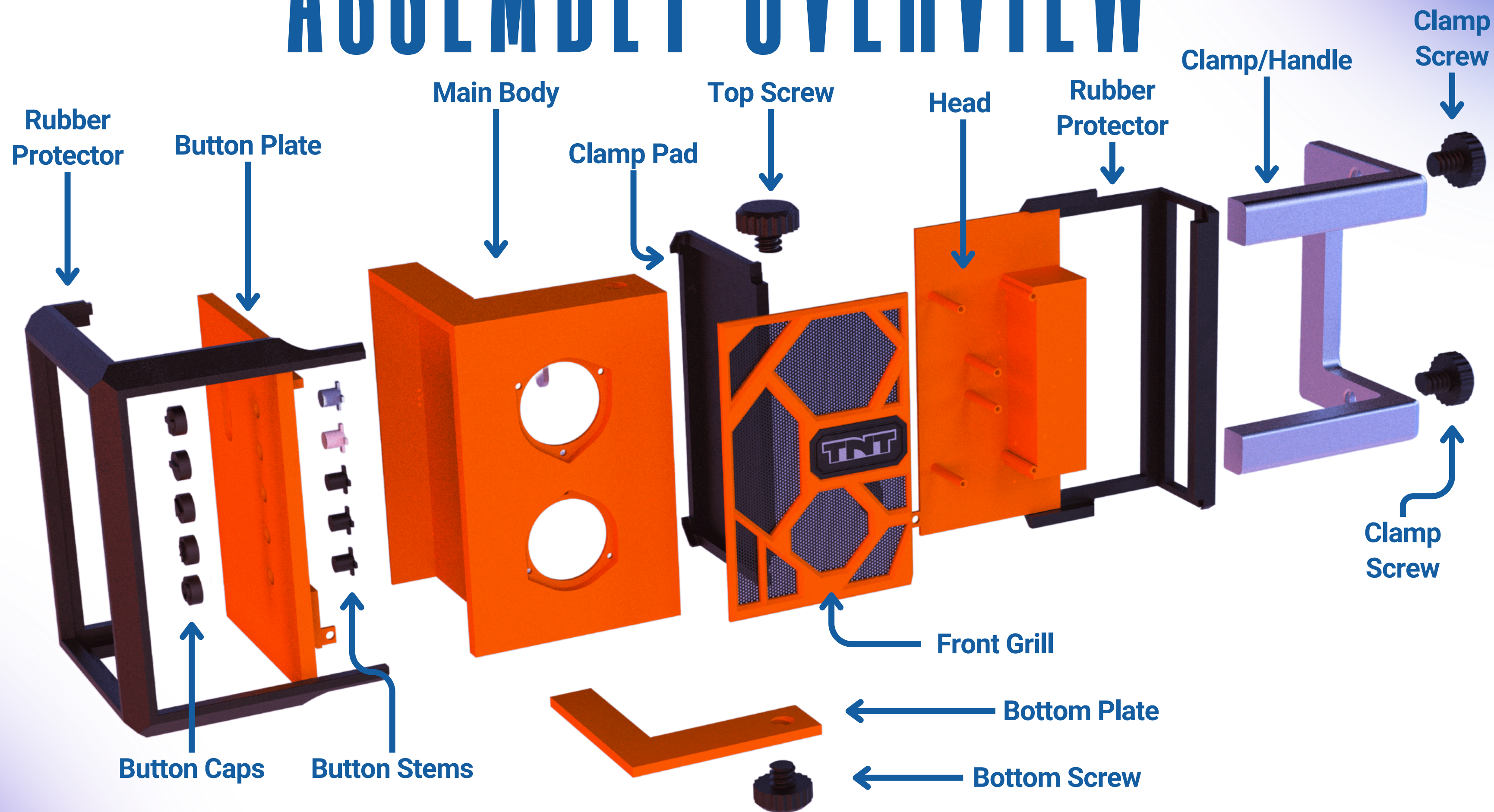


WORKING PROTOTYPE / ASSEMBLY





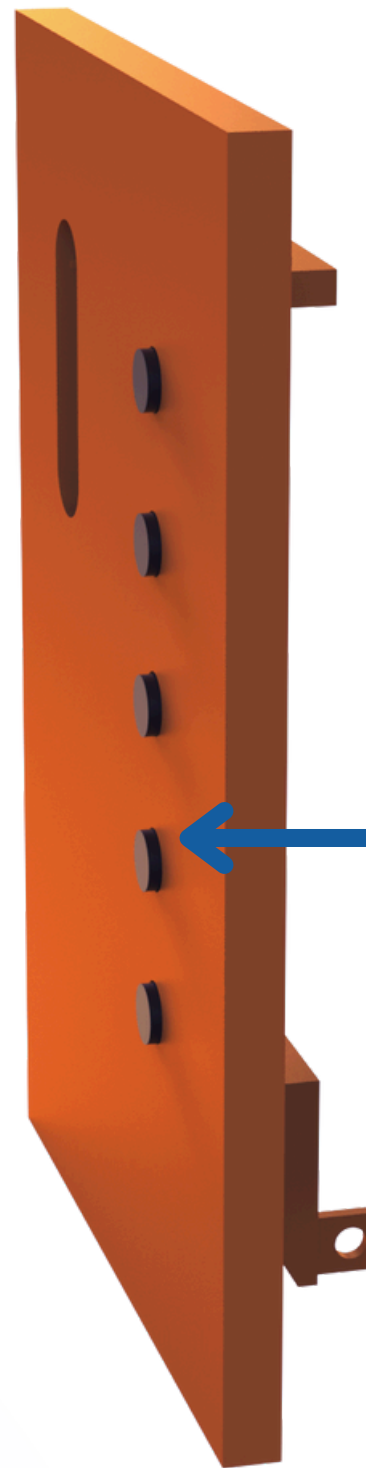
ASSEMBLY OVERVIEW





ASSEMBLY OVERVIEW

Button Caps
glued on top of
Button Backs

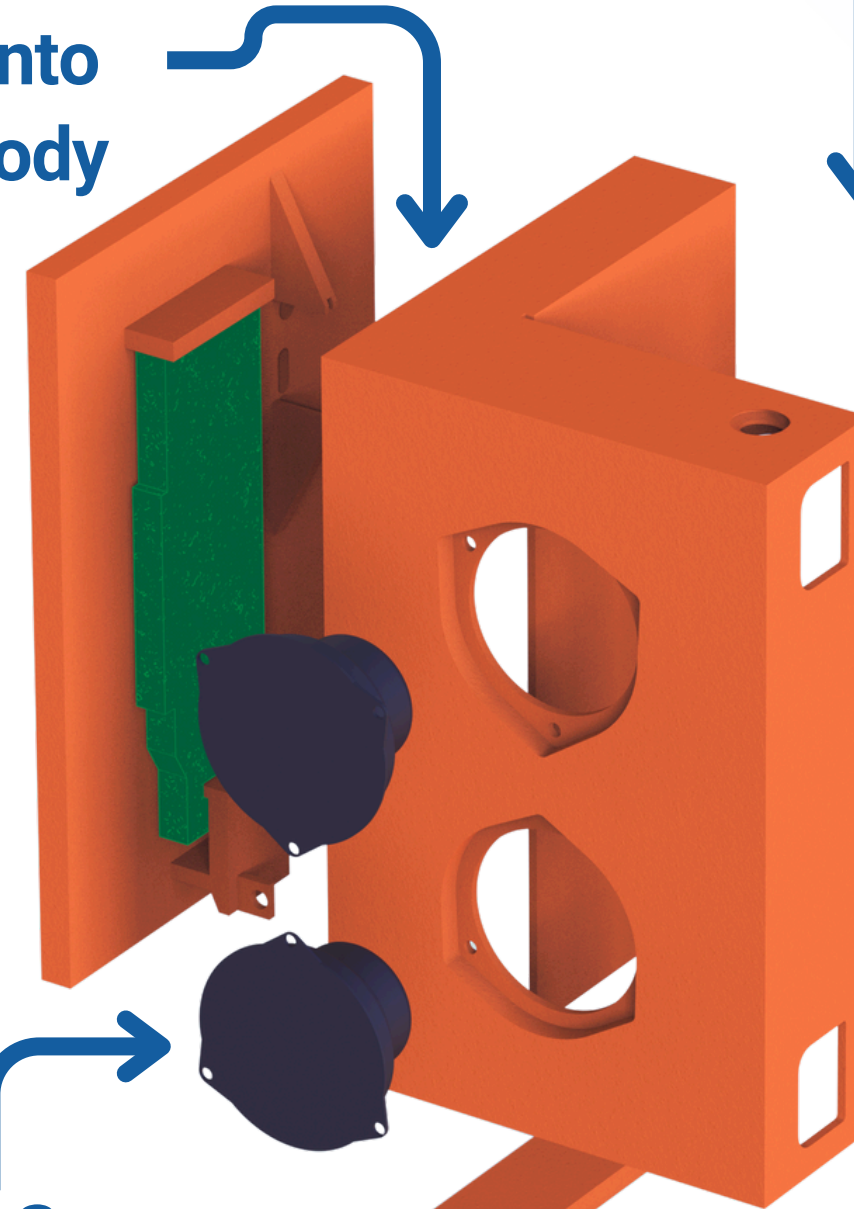


← Mother Board
slots in built
in friction fit

Button Backs
go in back site
of Button Plate

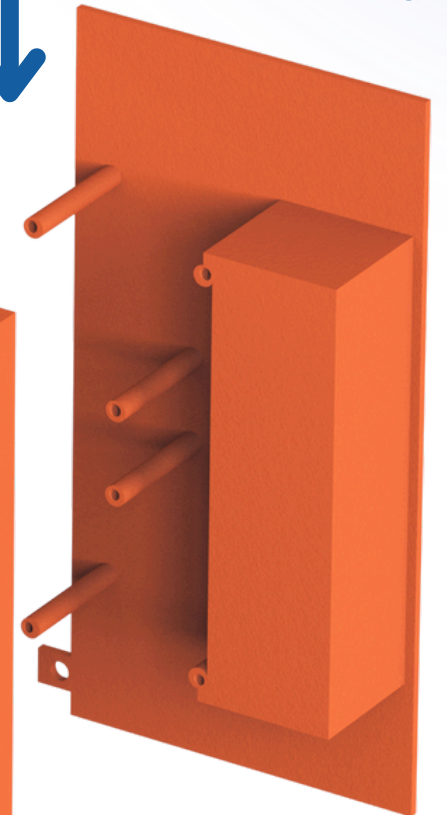


Button Plate
Glues into
Main Body

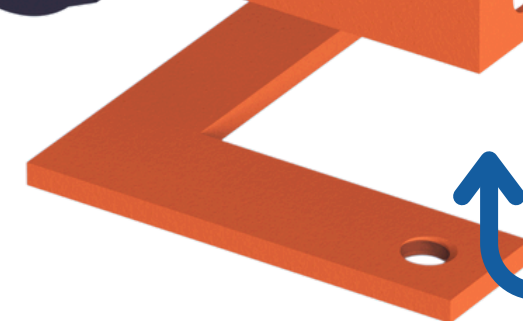


Drivers Screw
through Main
Body and into
Back Plate

Back Plate held
in by small bolt
and glue to Main
Body

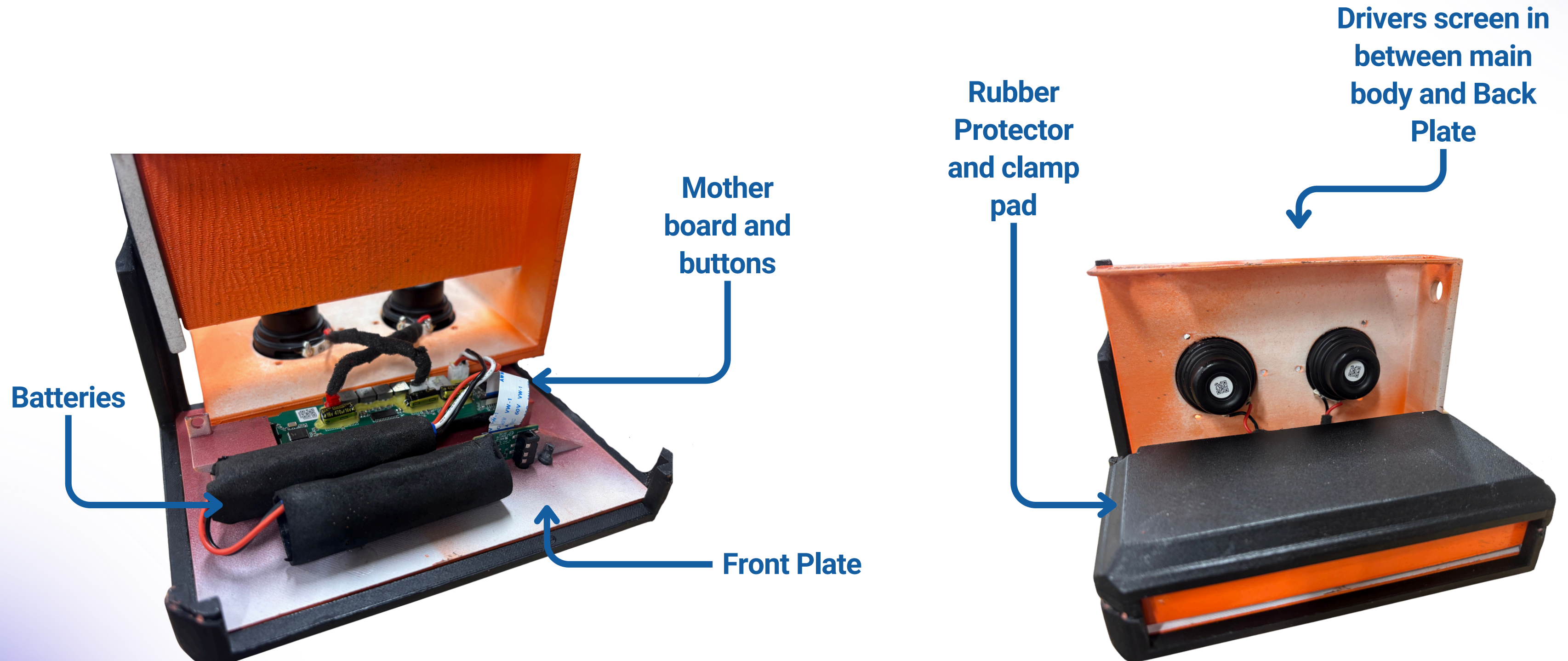


Bottom Plate
Glues into
Main Body





ASSEMBLY OVERVIEW





ASSEMBLY OVERVIEW

Protector slides
onto Main Body
friction fit

Clamp Pad
slides onto
and glued to
main body

Screws into
threaded hole

Slides into Main
Body

Glued to end
of Screws

Protector slides onto
Main Body friction fit
interlocks with other
Protector

Screws into
threaded hole

Screws into
threaded hole

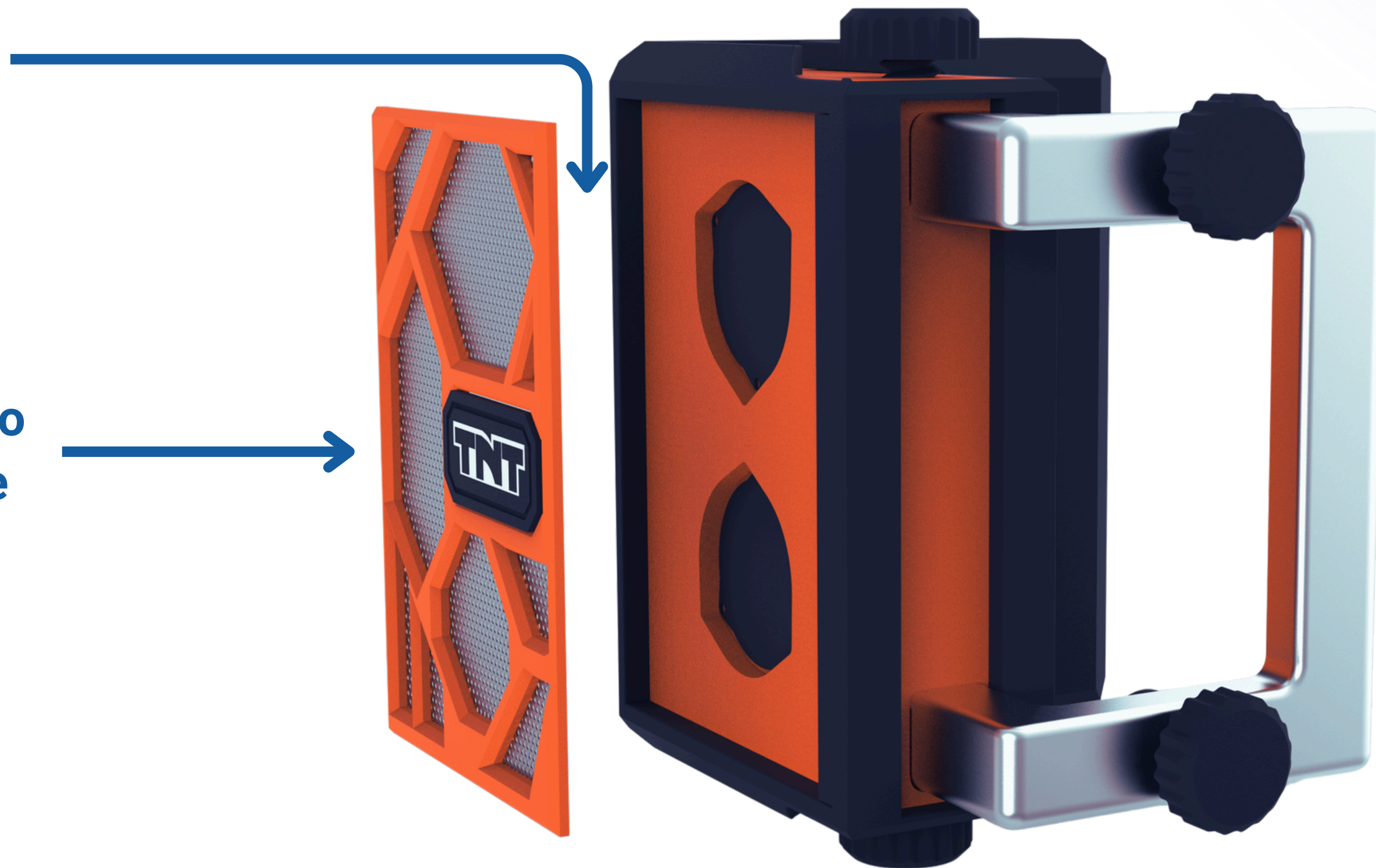




ASSEMBLY OVERVIEW

Glues on to
Main Body
covering
drivers

Grill glues to
Front Plate





FINAL PROTOTYPE

3D print



Front Left

Back Right



Back Left

Right



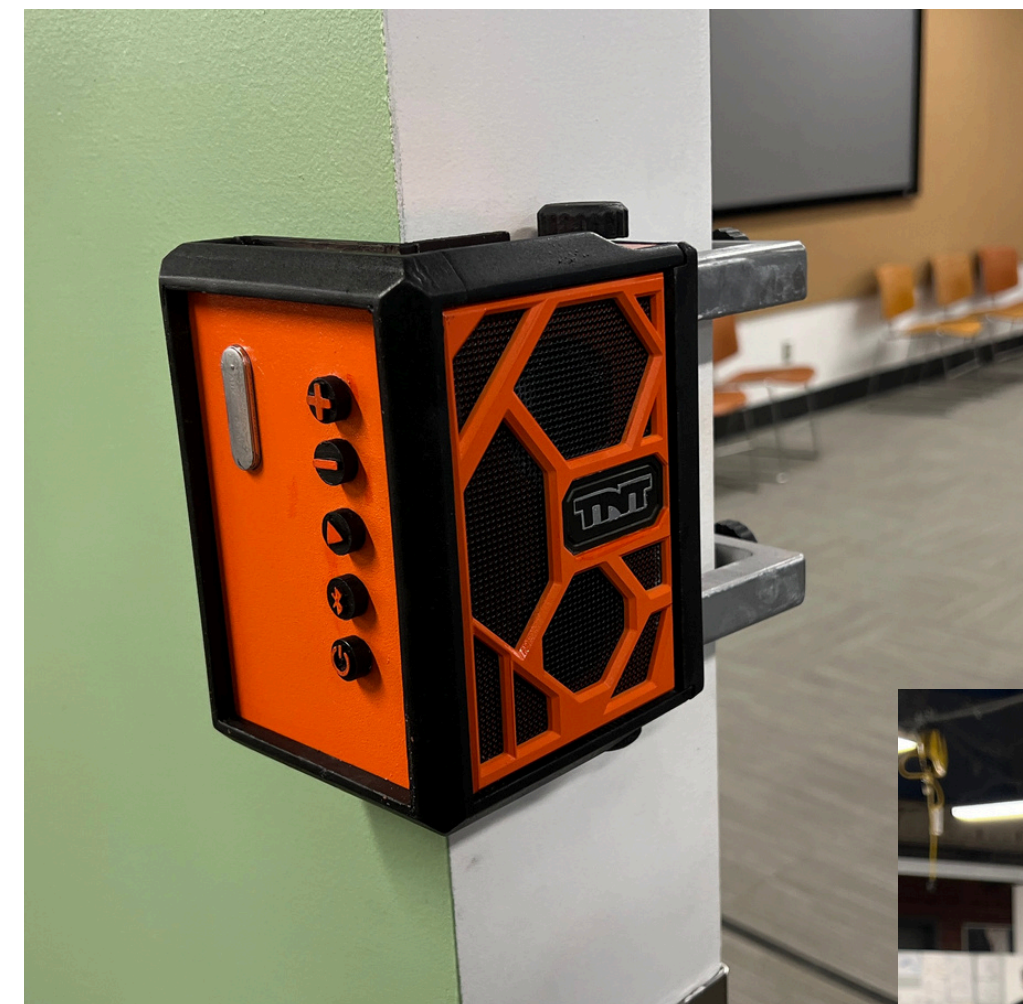


FINAL PROTOTYPE

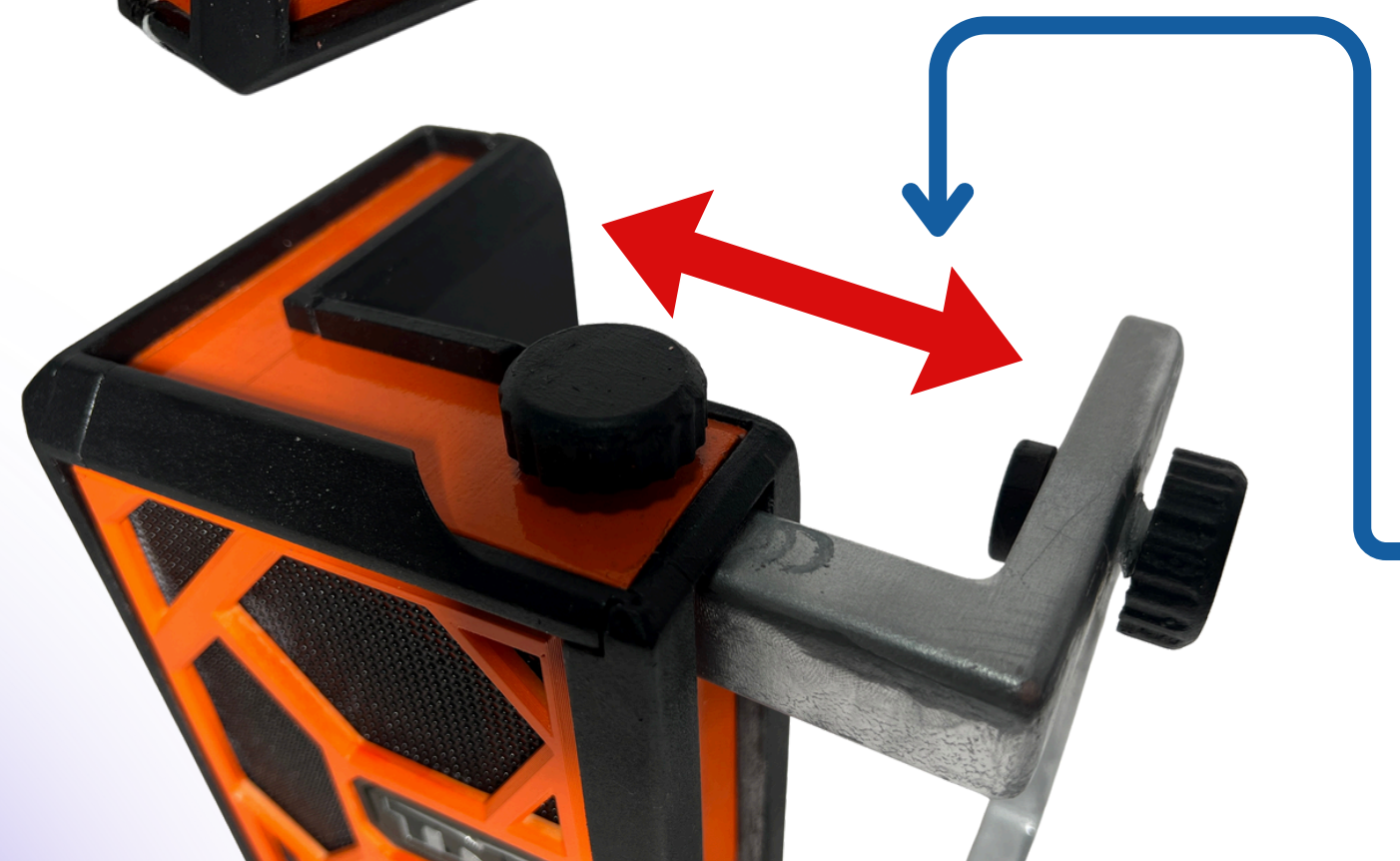
3D print

Buttons

- Volume Up
- Volume Down
- Pause/Play
- Bluetooth
- Power On/Off



In Use on
wall



Clamp
Functionality.





FINAL PROTOTYPE

Video





REFLECTION

When I think back on this project, the biggest insight I gained was that designing for a specific user changes almost everything. Once we committed to focusing on a framer working construction, the details started to make sense in a way they hadn't before. The teardown phase showed me how many little tradeoffs go into a speaker, like the cheap plastic housing, the way ports were exposed, and how fragile the grille really was. Those weren't just random choices; they were decisions that worked fine for casual home use but clearly wouldn't survive a construction site. That realization helped me see how much the final design needed to be tougher, louder, and easier to handle with gloves.

One of the toughest challenges I ran into was balancing all the ideas we had with the physical constraints. We only had 9x4x4 inches to work with, which meant I couldn't just keep adding features endlessly. For example, I wanted a strong clamp and a magnet, but I also had to make sure it was feasible and would fit within the constraints. I overcame this by prototyping with foam and cardboard. Some of the mockups looked rough, but they helped me see right away if the form was too bulky or if the buttons were too close together. Without those low-fidelity prototypes, I probably would have pushed ahead with shapes that looked good in sketches but were impractical in real use or did not really have anything special to them function-wise.

What I learned about user-centered design is that it isn't only about empathy, it is also about translation. Construction workers don't ask for "ergonomic controls"; they just want something that works with gloves and doesn't break when dropped. That meant translating their needs into design responses like big buttons, a dust-resistant grille that doesn't clog, and sealed ports so a hose spray won't kill the electronics. Prototyping forced me to test those assumptions in my own hands, and that made the design stronger every step of the way.

The final product feels like it embodies the goals I set at the beginning, and I feel like we did a great job with what we were given. It has the durability and ruggedness of a tool, glove-friendly controls, and flexible mounting. It isn't just a Bluetooth speaker anymore, it's something that looks and functions like it belongs on a construction site.



END

