

dyson exoglove AirGrip

* Dyson Limited was not engaged in any consultancy or collaborative capacity with this project and the outcome is in no way endorsed by them. Any publicity is limited to personal and academic use.

product opportunity

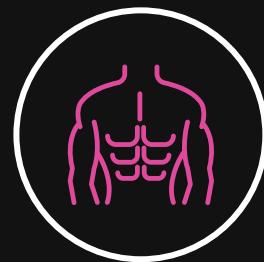
The traditional design of power tools, predominantly tailored for men, often overlooks the **specific needs and experiences of women**, posing ergonomic and usability challenges. A product solution is needed to address these limitations, enhancing grip strength and reducing the physical effort required for tool operation.

- The Exo Glove empowers women by providing the necessary support and strength for home improvement tasks, ensuring physical capability does not limit ambition.

insights - key issues



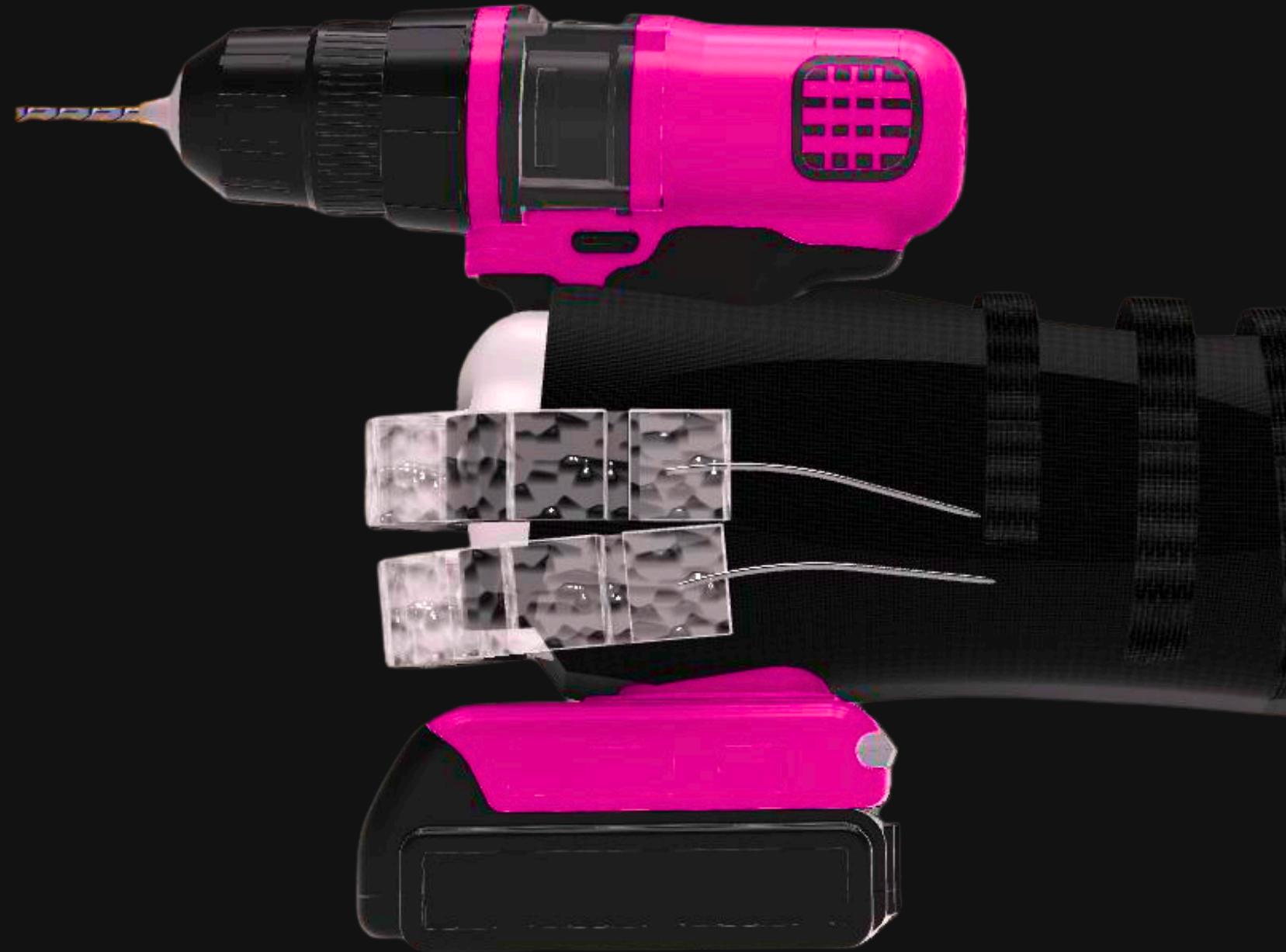
Grip strength



Upper Body Strength



Vibrations



Goals

- Improve grip strength for women DIY enthusiasts through advanced air pump and soft robotics technology.
- Minimise fatigue and prevent injuries with ergonomic design
- Address gender biases in tool design by creating a women-centric product

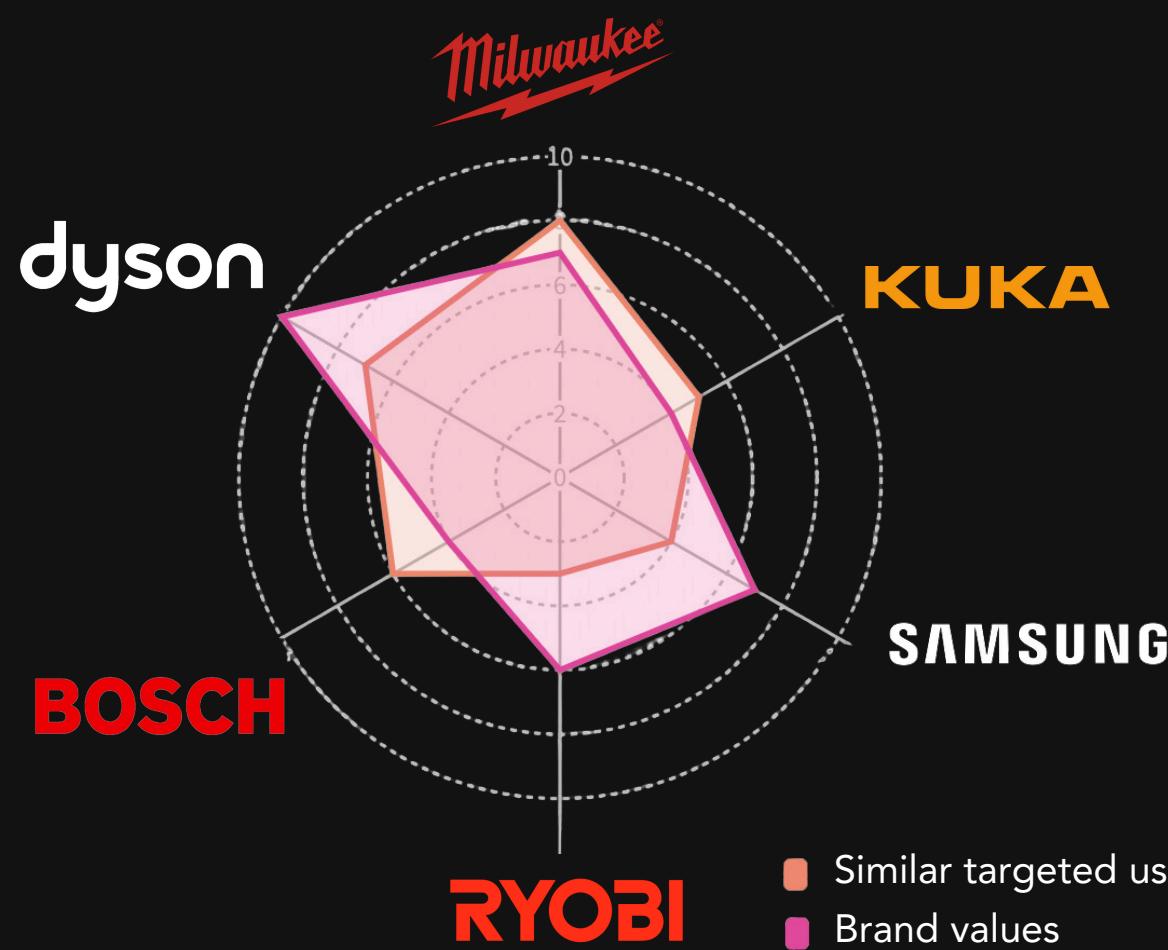
HMW

make power tools universally accessible, transcending gender biases and challenging the notion that has seen men as the default human model?

branding

Selection matrix

Brands with aligned brand value and similar target markets are selected and ranked using a radar chart.



dyson

Their cutting-edge engineering and R&D capabilities align with the Exo Glove's need for advanced technology like air pumps and soft robotics.

Dyson's reputation for high-quality products instills confidence in users, and their strong consumer market focus aligns with our target audience.

Brand selection

Summing the scores obtained in the two categories, the top three brands were selected for further analysis:



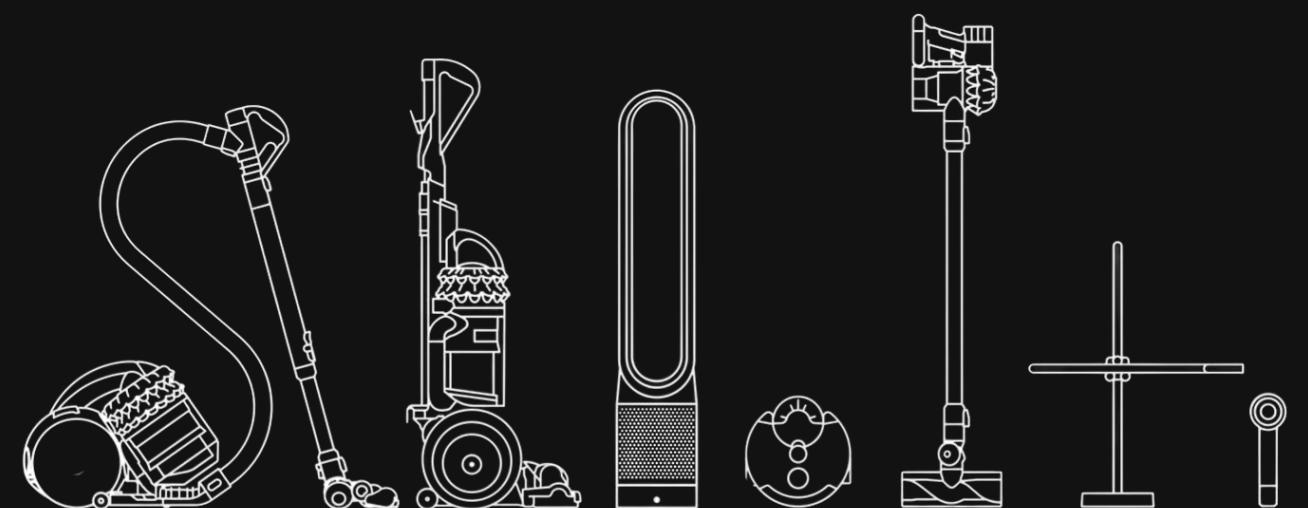
Focus on heavy-duty, reliable tools for professionals

Pursuit of innovation, enhancing productivity with cutting-edge ergonomic design



Focus on integrating advanced technology and smart features

Enhance their smart home solutions and appeal to their tech-savvy target consumers.

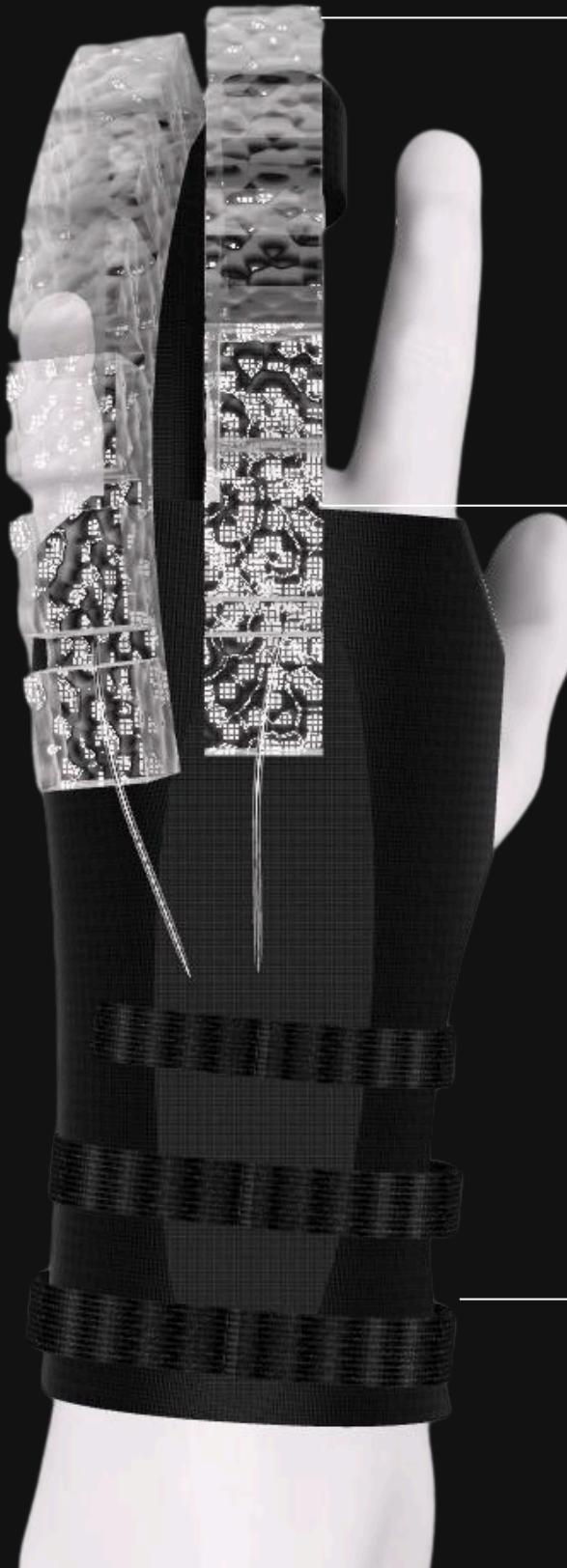


Dyson is a British tech company known for innovative household appliances

concept development - product functions

initial concept

Inspired by the Robo-Glove, developed by NASA and General Motors to reduce repetitive stress injuries, the Exo Glove was designed as a battery-operated exoskeleton glove with artificial tendons and forearm actuators.



Development

Sensors

How might we detect when the user is using a tool?
Piezoelectric Sensors, Capacitive Touch Sensors were tried out, but FSRs are selected due to their appropriate sensitivity and lightweight design



Bending mechanism

How might we improve the user's grip?

Considered electromechanical actuators, exoskeleton with servo motors, and silicone actuators



Selected the silicone actuators since they are lighter and more comfortable. This design uses solenoid air valves, air pumps and silicone actuators controlled by force-sensitive resistors (FSRs).

Form

How might we design the glove?
The open design balances protection with comfort and flexibility, using breathable, stretchy fabric for greater dexterity and natural movement.



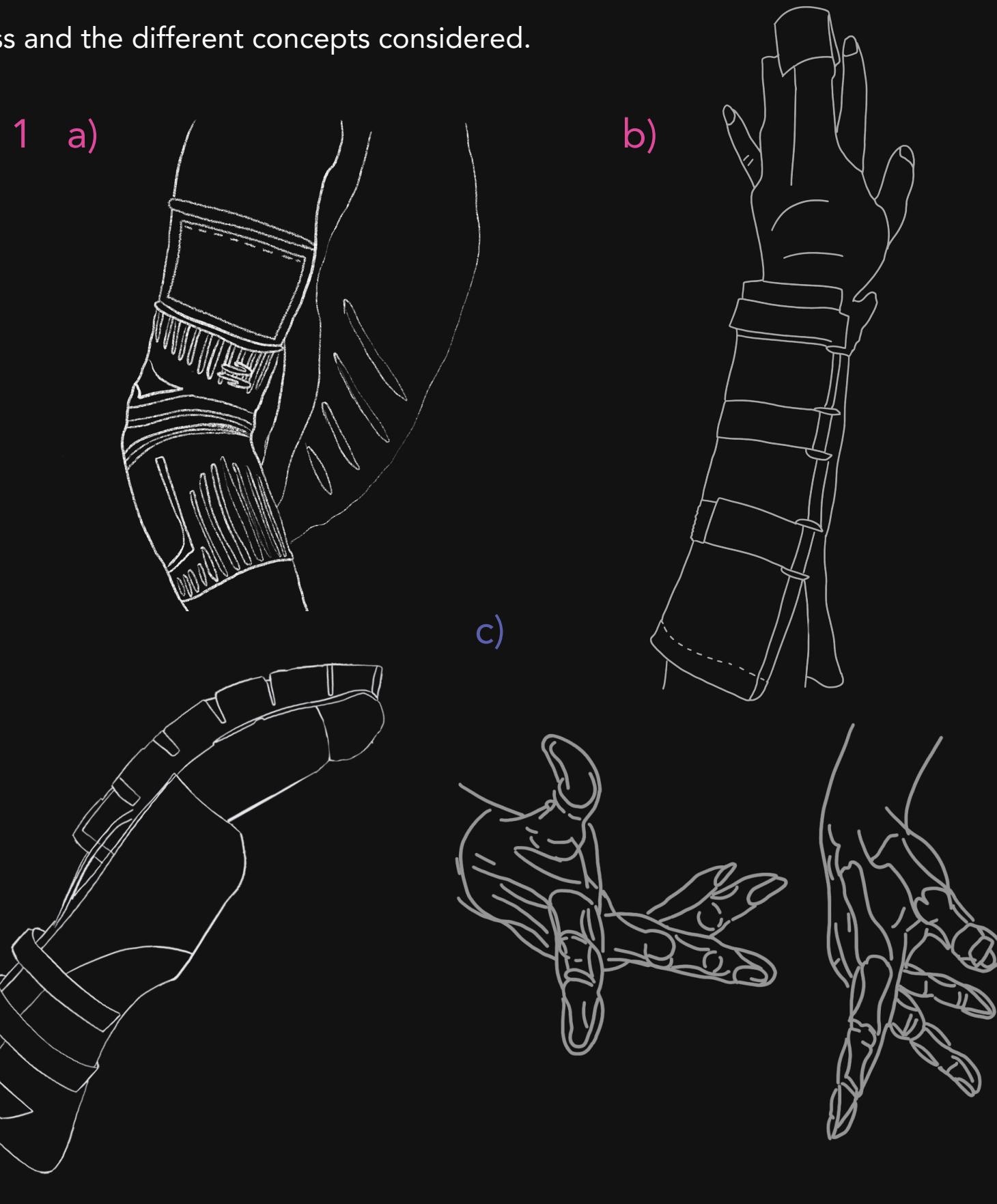
concept development - product form

Design iteration

The following sketches offer valuable insights into the design process and the different concepts considered.

1 Mechanism: different methods to efficiently place the different components are considered. The battery pack can be positioned on the lower arm (a) or along the upper arm near the shoulder (b).

2 Glove designs: a completely closed safety glove (a) , an open design with partial coverage and actuators only on ring and middle fingers (b),and a minimalistic approach using only silicone actuators connected to fingers with elastic bands (c).



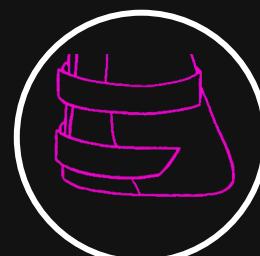
concept development - product interactions

user experience

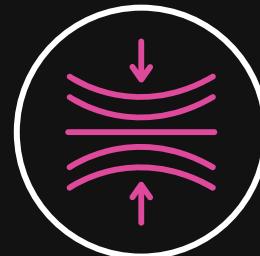
The Exo Glove interaction design is meticulously crafted following the development of its functional and aesthetic concepts. Here's the comprehensive user experience process:



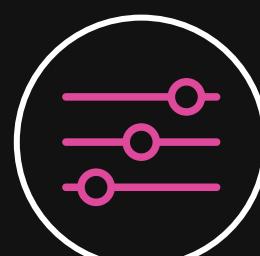
Start: User powers on the glove by pressing the power button located on the battery pack. Ensure that the battery is charged. The glove is designed to be ambidextrous.



Fitting Adjustment: User slips the glove onto their hand, ensuring the fingers align with the corresponding slots and the wrist strap wraps comfortably around the wrist. User secures the glove using the Velcro straps for a snug fit.



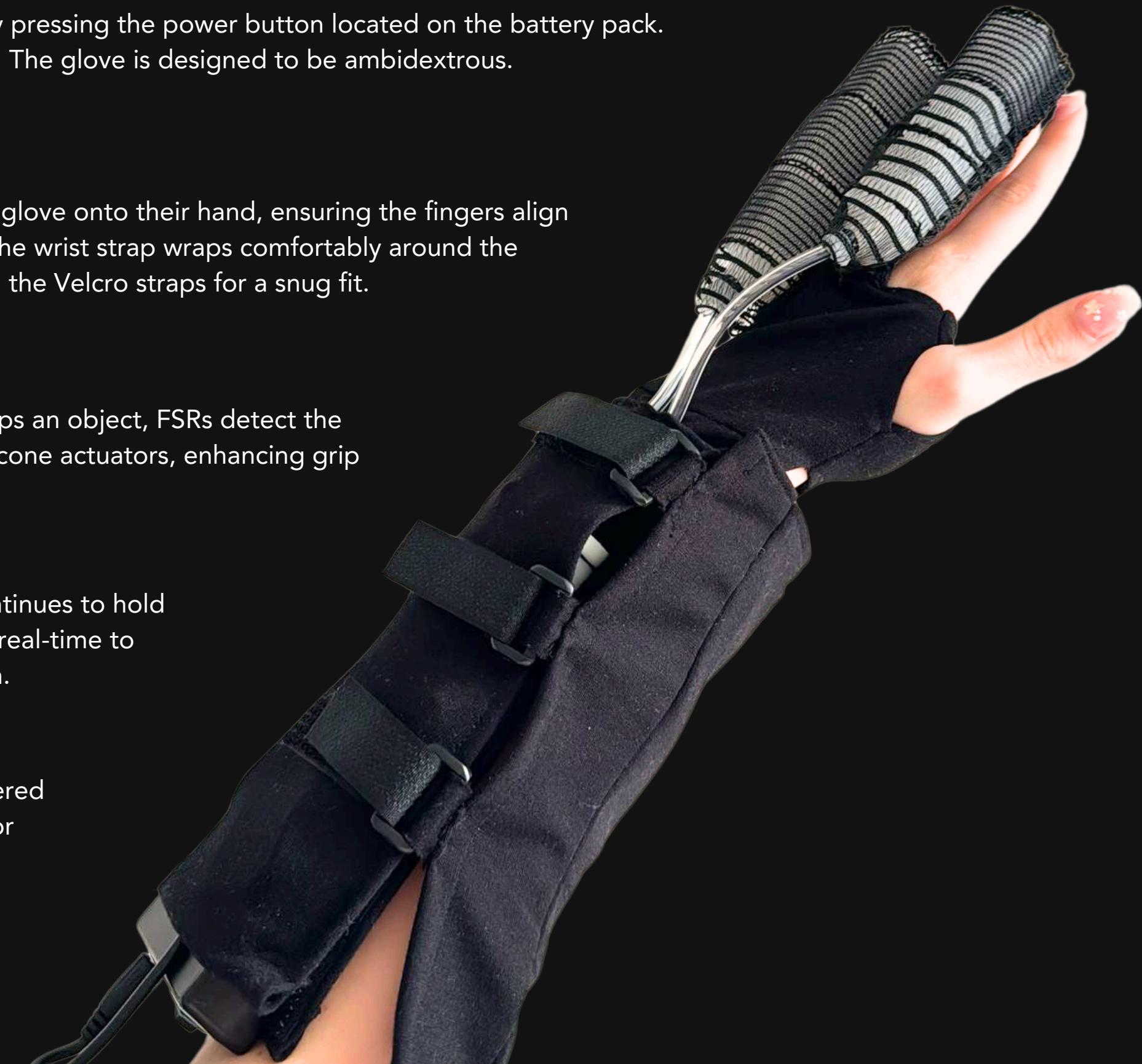
Grip Activation: When the user grips an object, FSRs detect the pressure. The air pumps inflate silicone actuators, enhancing grip strength.



Grip Maintenance: As the user continues to hold the object, the actuators adjust in real-time to maintain a consistent grip strength.



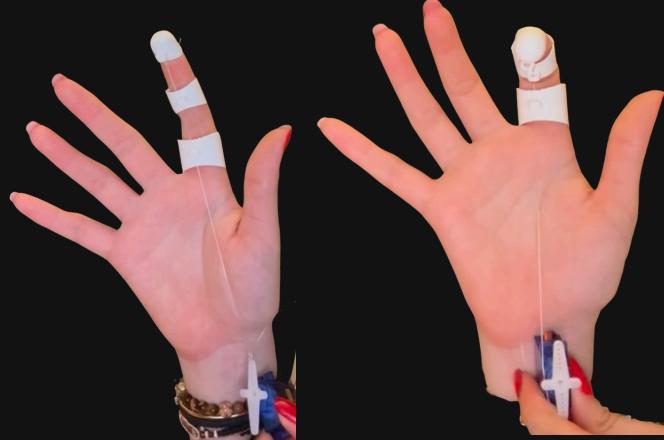
Power Off: The glove can be powered off by holding the power button for three seconds.



prototyping

Mechanical and Electrical

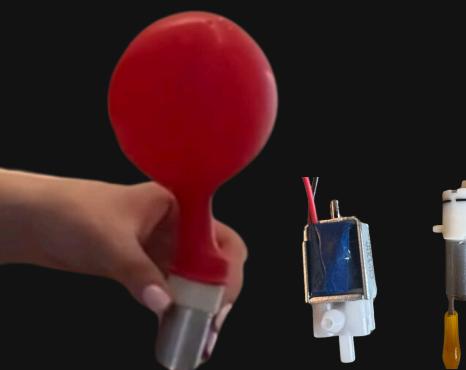
Pulley system



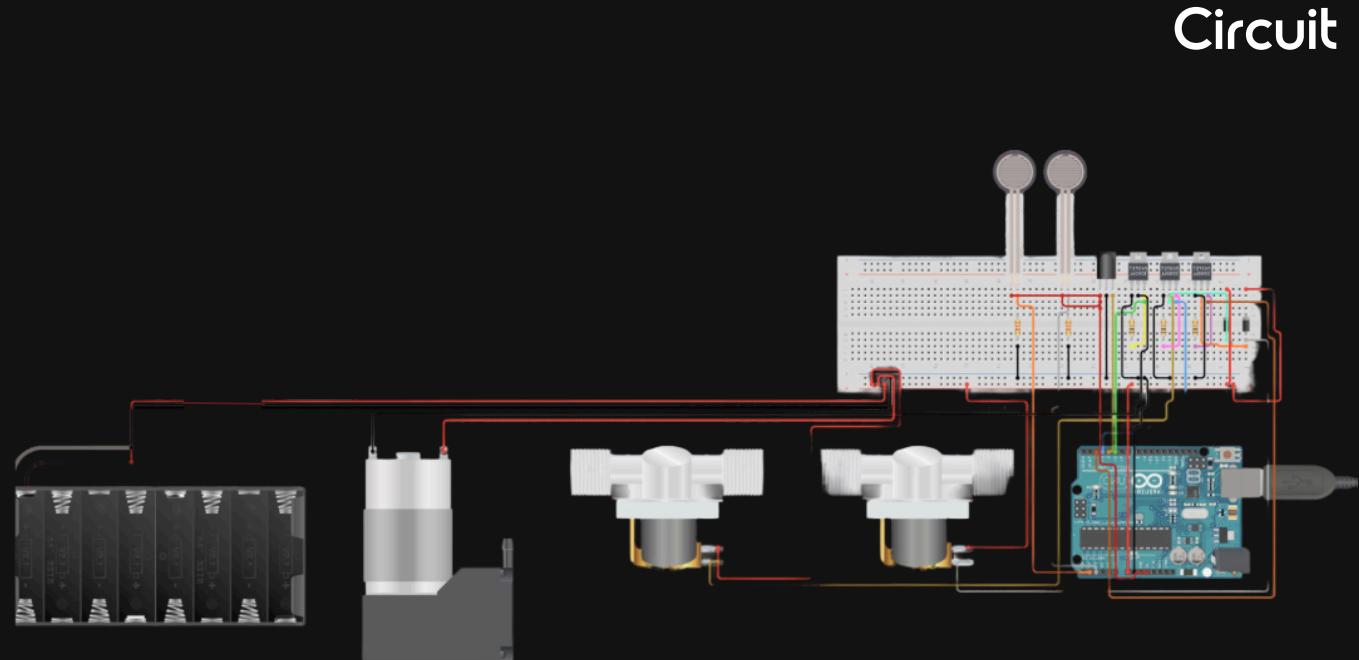
3D printed finger joints with servo motors were too bulky for the glove and lacked sufficient strength and range of motion to bend the fingers effectively.

Mechanism

Inflation mechanism



Using balloons to simulate actuator air pressure. Air pump could only inflate and need valve to deflate.



FSRs connect to Arduino analog pins for real-time pressure reading. Control logic includes a maximum pump time to prevent overinflation. If pressure exceeds a threshold, air pumps inflate the actuators; if below, the system deflates them, enhancing grip.

Mold for actuators

The design and production of molds are crucial for the soft robotic actuators' functionality. Initial molds were created using AutoDesk and produced with a Prusa 3D printer using Eco Flex 20-30 silicones. Silicone was injected into molds and allowed to cure before assembly.

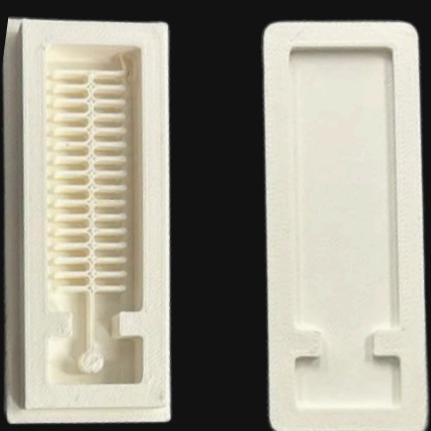
1 Simple design:



2 Clamping System:



3 Ribbed Morphology:



The base mold is a flat plate with a lip, while the main mold is a two-part design. Second mold was best for preventing popping and allowing better bending. The ribbed morphology design did not bend well when inflated.

power and component load calculations

Battery selection

In selecting the optimal battery for the Exo Glove, key requirements included functionality, sustainability, and user convenience. A rechargeable battery was essential for frequent use and sustainability. The battery needed to be lightweight, crush-resistant, and energy-efficient.

Lithium-ion vs Alkaline

Lithium-ion batteries offer high voltage, compact size, and rechargeability, making them ideal despite their higher cost and need for careful management. Alkaline batteries are cheaper but non-rechargeable, bulkier, and less portable. Lithium-ion batteries were selected.



Power requirement

Each MOSFET's 20mA operating current is minimal compared to other high-power components. The resistors also consume negligible power. Most power consumption comes from the continuous operation of air pumps and solenoid valves. **Total power requirement is 19.48W.**

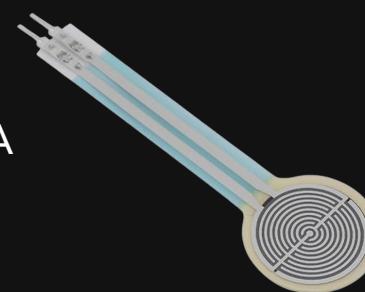


To sustain 8 hours of use, we selected a 12V lithium-ion battery matching the solenoid air valves and air pumps, requiring 155.84Wh (19.48W x 8h). Each 18650 battery (3.7V, 3000mAh) provides 11.1Wh, so 14 batteries are needed. We configured them in a **3S5P setup** (3 cells in series, 5 parallel strings), totaling 15 batteries and 166.5Wh. This configuration supports 8 hours of continuous use.



MOSFET transistor

- Operating Voltage: 5V
- Operating Current: 20mA each
- Total Power: 0.4W



Force-Sensitive Sensors (FSRs)

- Operating Voltage: 5V
- Operating Current: 1mA each
- Total Power: 0.01W



Air Pumps

- Operating Voltage: 12V
- Rated Current: 400mA each
- Total Power: 9.6W



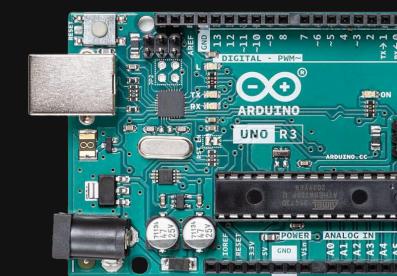
Solenoid Air Valves

- Operating Voltage: 12V
- Rated Current: 380mA each
- Total Power: 9.12W



Diodes

- Operating Voltage: 5V
- Operating Current: 10mA each
- Total Power: 0.1W



Arduino Uno REV3

- Operating Voltage: 5V
- Operating Current: 50mA
- Total Power: 0.25W

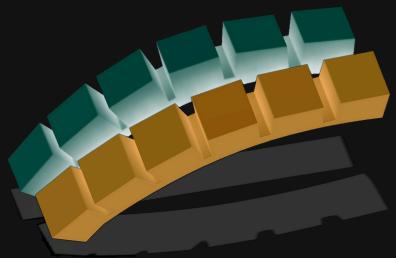
detailed design (DFMA)

Key parts and assembly features

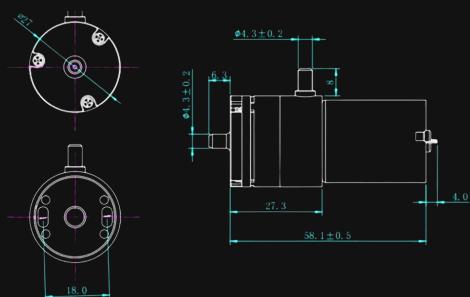
Design for Manufacturing and Assembly principles were rigorously applied in developing the Exo Glove for ease of manufacturing, cost efficiency, and high performance.



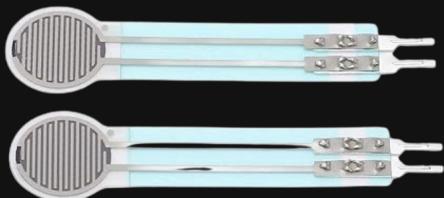
The **glove base** uses a durable, breathable synthetic fabric with integrated mesh panels for airflow and adjustable Velcro straps for a secure fit. Easy to cut, sew, and assemble, it features durable seams and reinforced high-stress areas like fingertips and palm for extended lifespan.



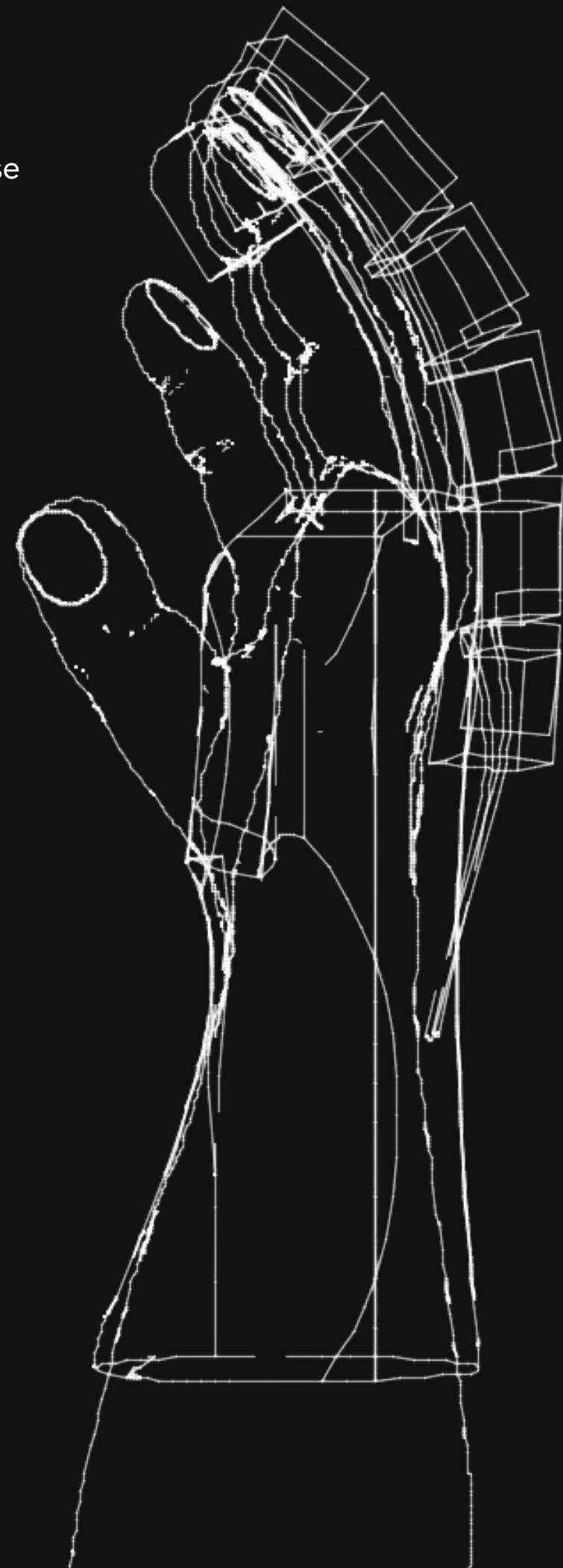
Silicone bending actuators, made from Ecoflex 20 and 30, are embedded in the glove for grip enhancement, placed on the ring and middle fingers. They connect to the air pump system via silicone tubing in fabric channels. Including a non-stretchable layer (e.g., a thin PET layer) at strategic points could help guide the bending motion.



Air Pump (technical drawing) **and Valve System**: This system has compact, 3D-printed housings with safety features like pump time checks and deflation delays. Quick-connect fittings simplify assembly and maintenance by ensuring secure connections between tubing, valves, and actuators.



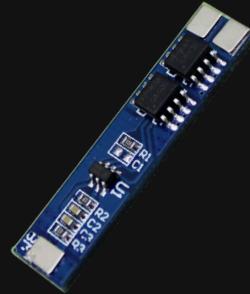
FSRs on the ring and middle fingertips detect grip pressure. Control logic activates pumps when pressure exceeds a threshold and deflates actuators when it drops. Calibration ensures accurate pressure readings by using known weights to create a resistance value curve.



detailed design (DFMA)

DFMA principles were applied to the product's electronics to streamline production and enhance reliability. This approach includes the design and integration of the battery pack, power management system, and microcontroller.

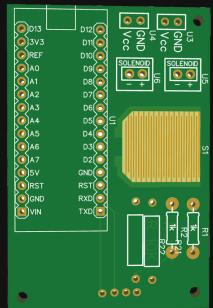
The **battery pack** uses a 3S5P configuration with 18650 lithium-ion batteries, housed in a separate, accessible compartment with a secure locking mechanism.



A Battery Management System (BMS) monitors cell voltages, manages charging/discharging, balances cells, and provides overcurrent, overvoltage, and thermal protection.



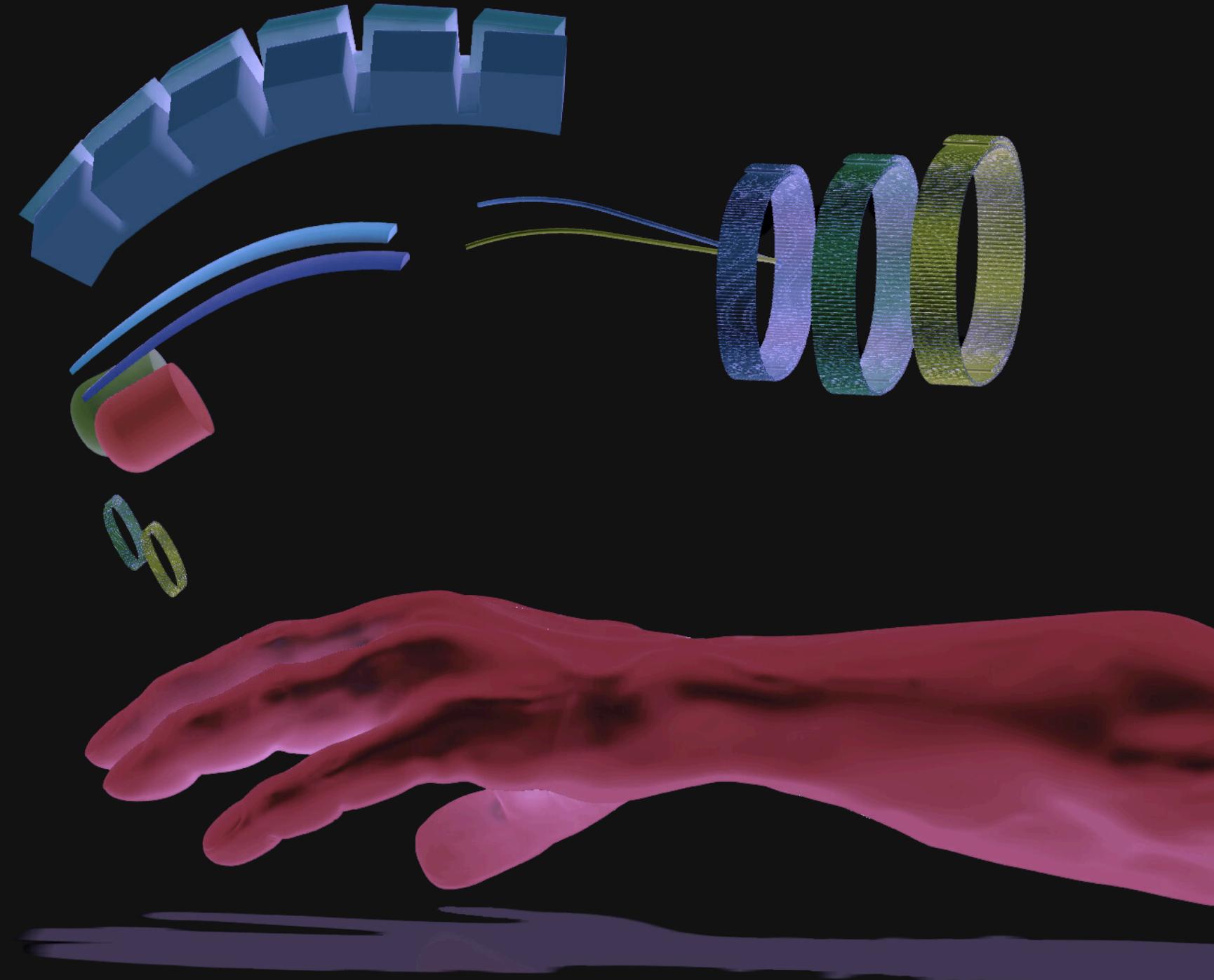
Battery holders ensure insulation and prevent short circuits. Including a fuse adds extra safety.



For mass production, **custom PCBs** with dedicated microcontrollers are preferred over Arduino boards for cost and space efficiency.



Options include the ATmega328P for cost reduction or the ESP32 for built-in Wi-Fi and Bluetooth, ideal for IoT applications.



product assembly process

Glove assembly



The fabric for the Exo Glove is precisely cut and sewn, incorporating high-friction grip material in key areas to ensure better handling and control when using tools. Adjustable Velcro straps are added to provide a customisable and secure fit for users of various hand sizes.



FSRs are positioned on the fingertips to detect grip pressure, allowing for control of the glove's actuators.

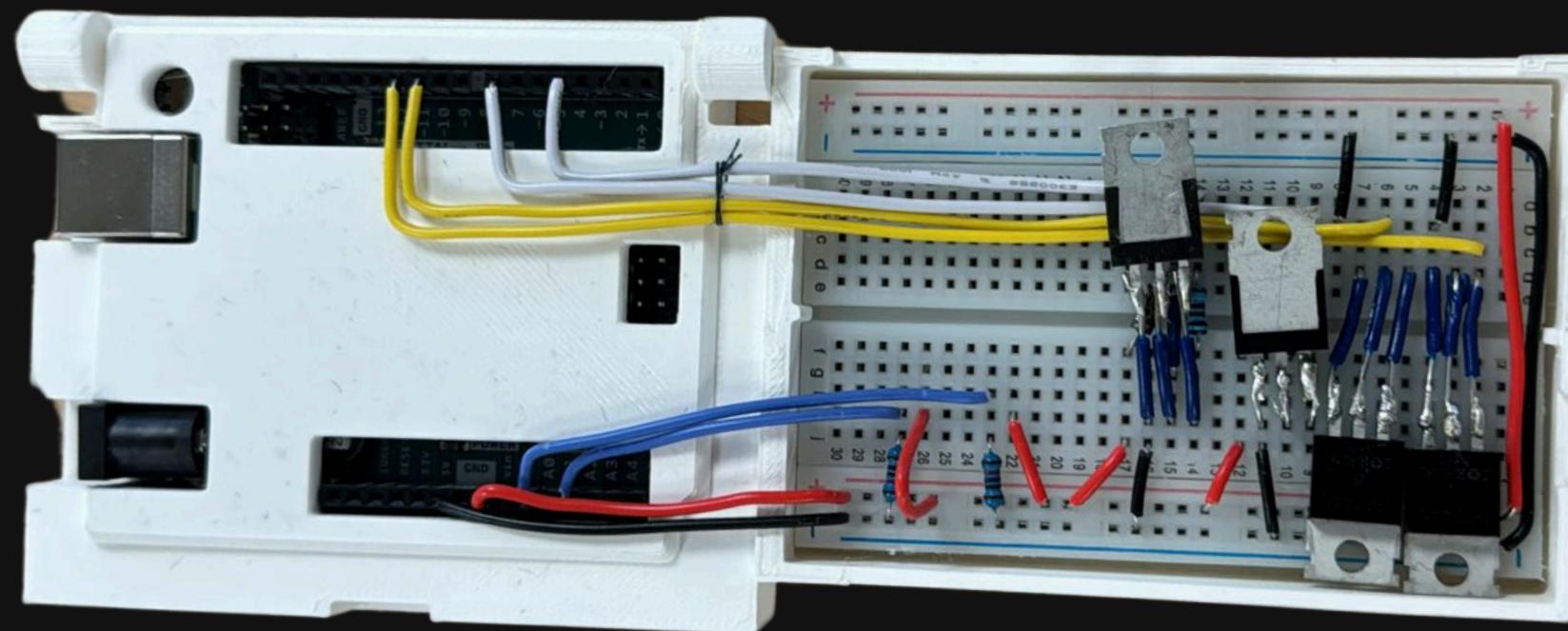
Silicone actuators are crafted from Ecoflex silicone. The silicone is mixed in a 1A:1B ratio and poured into 3D-printed molds before being cured. These actuators are embedded within the glove.

The glove is designed to work on both hands, featuring an appropriate opening for ambidextrous use.

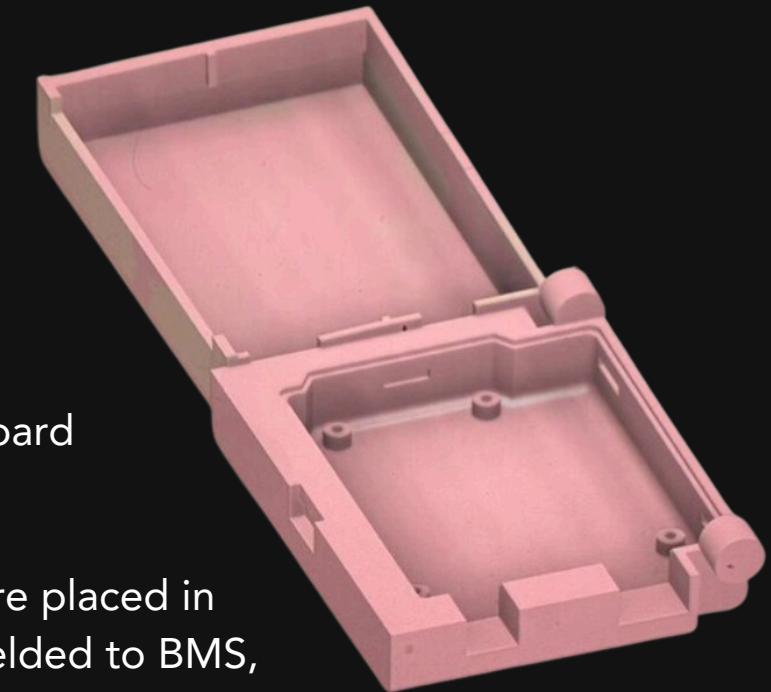


Electronics assembly

An appropriate case was designed using AutoCAD and 3D printed, providing space for both the breadboard and Arduino. Wires were cut to the required lengths and soldered for precise connections.



Batteries are placed in holders, welded to BMS, and connected to PCB.



Actuators were embedded within the glove and connected to the air pump system. Pumps and valves were securely installed in glove compartments using quick-connect fittings. FSRs were connected to the PCB. All components were then integrated, connections secured, and functionality thoroughly tested.

branding implementation

Justification

Dyson's reputation for innovative, high-quality engineering, especially in air-based technology, aligns perfectly with the Exo Glove's advanced, user-centric design. The name "Exo Glove: AirGrip" highlights the glove's use of air technology to enhance ergonomic support and strength, fitting Dyson's tradition of emphasising functionality and technological sophistication.



The Exo Glove, priced at £200, positions itself as a premium product, reflecting Dyson's market positioning and appealing to those who value quality and innovation.

Colour Scheme

Dyson products are known for sleek, modern aesthetics. The selected colours are reflective of Dyson's typical palette. This choice maintains a cohesive brand image and appeals to Dyson's existing customer base.

Main Colour:

- Dark Grey (#4D4D4F): A sleek and professional shade of grey to provide a modern and sophisticated look that aligns with Dyson's design aesthetics. This colour emphasises the product's solid engineering and functionality.



Accent Colors:

- Fuchsia (#DF499B): A vibrant and modern touch to highlight branding elements. It is chosen for its energetic and appealing contrast to the dark base.
- Orange (#ED886F): Secondary highlights
- Red (#D6262A): Used sparingly for critical interaction points, ensuring high visibility and intuitive use.



Moodboard



branding implementation

Material

The glove is made from high-performance synthetic fabric and EcoFlex silicone, ensuring durability and comfort. Dyson commonly uses plastic, metal, and perforated fabric. For the Exo Glove, metal is excluded to keep it lightweight.

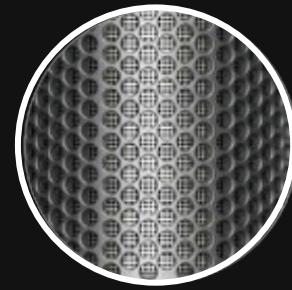
To align with Dyson's branding, the glove features **perforated fabric** around the actuators, allowing users to see the mechanism as they inflate and deflate.



Plastic



Metal



Perforated detail



Vision statement

"To revolutionise the DIY experience by providing innovative solutions that bridge the gap between ambition and physical capability, fostering independence and self-sufficiency."

Slogans

"Power in Your Hands: The Future of Wearables"

Additional:

"Elegance Meets Innovation: EXO GLOVE - AirFit"

"Precision, Performance, Perfection"

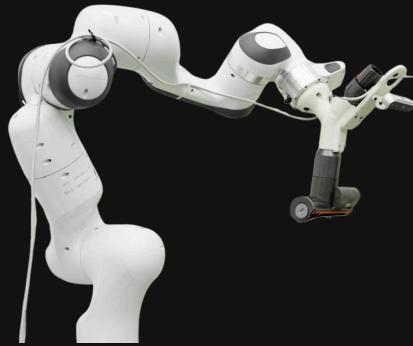
"Engineered for Excellence, Designed for Impact"

"Glove for every body"

Marketing and Distribution

The implementation involves using Dyson's extensive retail network and online platforms for distribution. Emphasis will be placed on the glove's innovative technology and benefits through promotional materials and real-world testimonials. **Dyson Demo Zones** will allow customers to experience the glove first-hand.

product compliance research



The Exo Glove is tailored for the UK and EU markets, leveraging Dyson's extensive manufacturing capabilities. Despite Dyson's headquarters relocation to Singapore, the company plans significant investment in a new £100 million Technology Centre in Bristol, UK.

This centre will complement Dyson's existing [Robotics Centre in Wiltshire](#), focusing on wearables and robotics, making it an ideal facility for producing the Exo Glove. Ensuring compliance with relevant regulations is critical for the product's safety and conformity.

EU Compliance

Indicates the product meets the EU's safety, health, and environmental protection requirements, facilitating free movement within the European Economic Area.



To achieve CE marking, a full risk assessment against the directive's essential requirements and harmonised standards must be conducted.

This involves identifying potential hazards, evaluating risks, and implementing mitigation measures. Comprehensive technical documentation must be maintained and updated to reflect any changes in product design, manufacturing processes, or regulations.



The documentation must include:

- Manufacturer's name and address.
- Product identification (e.g., serial number).
- Conformity assessment procedure statement.
- EU Declaration of Conformity.
- Compliance statements with relevant regulations and standards.

UK Compliance

Indicates compliance with UK regulations, replacing the CE marking post-Brexit. The UKCA marking has been required since January 2021.



The UK government recognises the CE marking for most products until at least December 2024 to provide businesses with flexibility during the transition.

To use the UKCA marking, manufacturers must ensure compliance with relevant UK regulations and maintain detailed technical documentation and a UK Declaration of Conformity. The marking must be clearly visible, legible, and indelible on the product, data plate, or packaging.



This documentation must be available for inspection by market surveillance authorities for up to 10 years after the product is placed on the market.

Products must come with relevant instructions and safety information in English, and the UK Declaration of Conformity.

product compliance research

Ensuring compliance with regulatory standards to secure UKCA and CE markings.

Laws and directives

EU Directives:



Radio Equipment Directive (RED) 2014/53/EU
• Maintain standards for radio spectrum use



RoHS Directive 2011/65/EU
• Limit hazardous materials in electronic equipment.



Electromagnetic Compatibility Directive 2014/30/EU
• Prevent emission to electromagnetic disturbances.



General Product Safety Directive 2001/95/EC
• Ensure product safety under standard usage conditions.



Machinery Directive 2006/42/EC
• Address extensive safety aspects



Packaging and Packaging Waste Directive 94/62/EC
• Manage packaging waste



Personal Protective Equipment Regulation (EU) 2016/425

Standards for Compliance

EN 300 328
EN IEC 63000:2018

EN 55032
EN 61000-3-2:2019

EN 61000-3-3:2013
EN 62493:2015

EN 50564:2011
EN 62133:2013

IEC 60086-4:2019
EN 50625:2014

UK Regulations:



The General Product Safety Regulations 2005
• Ensure product is safe under normal usage conditions.



Machinery (Safety) Regulations 2008



Restriction of Hazardous Substances in Electrical and Electronic Equipment Regulations 2012



Electromagnetic Compatibility Regulations 2016
• EMC Compliance: Minimise electromagnetic interference with other devices.



WEEE Directive 2012/19/EU
• Promote the recycling and safe disposal of electronic components.



Eco-design Directive 2009/125/EC
• Optimise the environmental performance of the product throughout its lifecycle.

Battery Directive 2006/66/EC
• Battery Management: Ensure the safe use, labeling, and recycling of batteries.

UKCA Conformity Declaration: certifies that the product meets all applicable statutory requirements.

product labeling

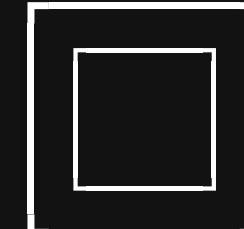
Product labels



CE and UKCA: Visible on label tag, indicating compliance with EU and UK regulations.



WEEE Label: On the battery compartment or near the power input, ensuring proper disposal.



Class II Electrical Equipment: Near the power input or battery compartment, indicating double insulation.



Manufacturer Information: On a tag attached to the glove or wrist strap, includes manufacturer details and safety instructions.



DC Symbol: Near the power input/output port, indicating direct current operation.

Battery labels



- UN Number: UN3481 for lithium-ion batteries in or with equipment.
- Battery Handling Label: Minimum size 100mm x 100mm, with a telephone number and lithium battery symbol.
- Capacity Labeling: For rechargeable batteries, capacity must be marked in mAh (whole number).
- RoHS Compliance: Conforms to Directive (2011/65/EU), limited use of hazardous substances.



Packaging labels



International Recycle Label: It should be placed on the exterior of the packaging. This label indicates that the packaging is recyclable.



The Green Dot: signifies producer responsibility, indicating that the producer has paid for the recycling of the packaging.



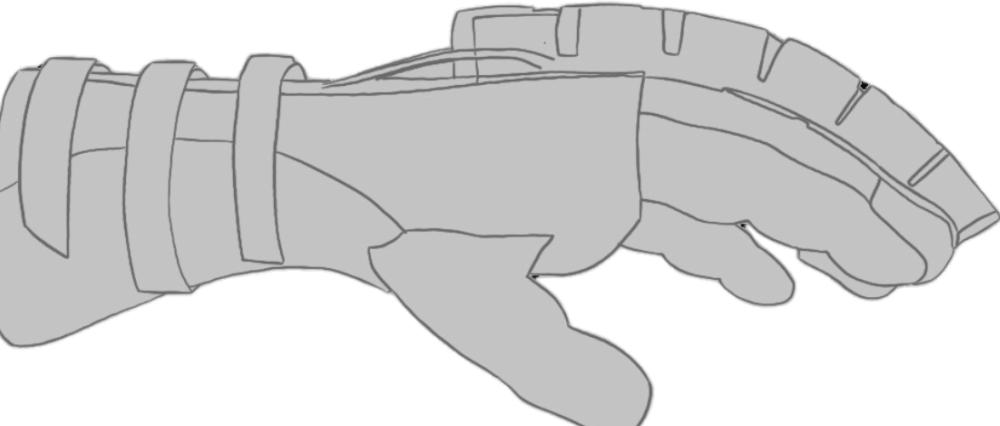
'Not suitable for children under 3' Label: It serves as a warning that the product contains small parts.

user guide



dyson Exo Glove: AirGrip

User manual



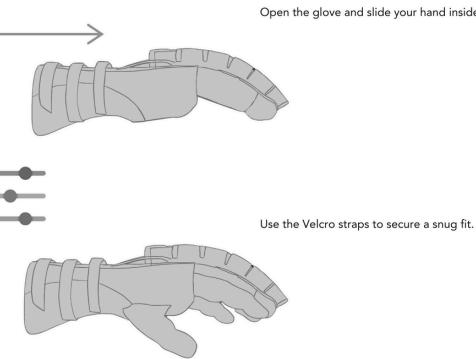
In the Box

EXO Glove main body
Charging cable
Adjustment tool
Protective cover
User guide (digital access)

* Dyson Limited was not engaged in any consultancy or collaborative capacity with this project and the outcome is in no way endorsed by them. Any publicity is limited to personal and academic use.

Assembling

Some tools may not be included.
You can buy additional tools at [Dyson.com](#)



Open the glove and slide your hand inside.
Use the Velcro straps to secure a snug fit.

Ensure the sensors and actuators are correctly positioned over the fingers and palm.

Getting Started

You can register your machine using the serial number found on the bottom of your machine.



Fully charge the battery before using the EXO Glove for the first time.
Regular charging is essential to maintain optimal performance.

Caring for your Exo Glove

Cleaning Your Glove:
Wipe the glove with a damp cloth and mild detergent.
Ensure the glove is completely dry before using it again.

Safety Precautions:

- Do not immerse the glove in water.
- Keep away from extreme heat sources.

Maintenance Tips:

- Use a Damp Cloth: Wipe the glove with a damp cloth to remove dirt and debris.
- Avoid Submerging: Do not submerge the glove in water or use harsh chemicals.
- Drying: Allow the glove to air dry after cleaning.

Maintaining the Battery:

- Alternate between batteries if you have more than one to maintain even performance.
- Charge regularly to ensure optimal performance.

Interaction and Control:

1. Power On/Off: Use the touch switch on the glove to power it on or off.
2. Grip Activation:
The glove automatically activates the air pumps when the force-sensitive resistors detect a grip. The actuators inflate, providing additional grip strength.

Release Mechanism: When the grip pressure is released, the air valves deflate the actuators, returning the glove to its resting state.

Storage:

- Store in a Cool, Dry Place: Keep the glove in a protective case when not in use.
- Avoid Direct Sunlight: Prolonged exposure to sunlight can damage the materials.

Warranty Period: The EXO GLOVE comes with a one-year warranty from the date of purchase.

UK Declaration of Conformity



Declaration of Conformity Number: EXO-UK-001
Name and address of manufacturer or authorised representative:
Dyson Ltd,
Tetbury Hill, Malmesbury, Wiltshire, SN16 0RP, UK

This declaration of conformity is issued under the sole responsibility of the manufacturer.
Object of declaration (identification of EEE allowing traceability):
EXO Glove AirGrip, Model Number: XG-12345

The object of the declaration described above is in conformity with relevant statutory requirements:

- RED 2014/53/EU
- The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012
- Electromagnetic Compatibility Regulations 2016
- The Ecodesign for Energy-Related Products and Energy Information (Amendment) (EU Exit) Regulations 2019

Where applicable, references to relevant designated standards or technical specifications used in relation to which conformity is declared:

- RF: EN 300 328 : V2.2.2, EN 300 328 : V2.1.1
- RoHS: EN IEC 63000 : 2018
- Health and Safety: EN IEC 60598-2-4 : 2017, EN 60598-1 : 2014 + A1 : 2017
- EMC: EN 301 489-1 : V2.1.1, EN 301 489-17 : V3.1.1 X, EN 55015 : 2019 + A11 : 2020, EN 61000-3-2 : 2019, EN 61547 : 2009
- EMF: EN 62493 : 2015
- Ecodesign: IEC 60335-1:2020, IEC 60335-2-26:2002+AMD1:2008

Additional information:
Class II Electrical Equipment Protection
IP53

Signed for and on behalf of: Dyson Ltd.
Place of issue: Malmesbury, UK
Date of issue: 18 June 2024
Name and function: John Smith, Managing Director
Signature: 

EU Declaration of Conformity



Declaration of Conformity Number: EXO-EU-001
Name and address of manufacturer or authorised representative:
Dyson Ltd,
Tetbury Hill, Malmesbury, Wiltshire, SN16 0RP, UK

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EXO Glove AirGrip, Model Number: XG-12345

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- RED 2014/53/EU
- RoHS 2011/65/EU + 2015/863
- ErP 2009/125/EC

Where applicable, references to relevant harmonised standards or technical specifications used in relation to which conformity is declared:

- RF: EN 300 328 : V2.2.2, EN 300 328 : V2.1.1
- RoHS: EN IEC 63000 : 2018
- Health and Safety: EN IEC 60598-2-4 : 2017, EN 60598-1 : 2014 + A1 : 2017
- EMC: EN 301 489-1 : V2.1.1, EN 301 489-17 : V3.1.1 X, EN 55015 : 2019 + A11 : 2020, EN 61000-3-2 : 2019, EN 61547 : 2009
- EMF: EN 62493 : 2015
- Ecodesign: IEC 60335-1:2020, IEC 60335-2-26:2002+AMD1:2008

Additional information:
Class II Electrical Equipment Protection
IP53

Signed for and on behalf of: Dyson Ltd.
Place of issue: Malmesbury, UK
Date of issue: 18 June 2024
Name and function: John Smith, Managing Director
Signature: 

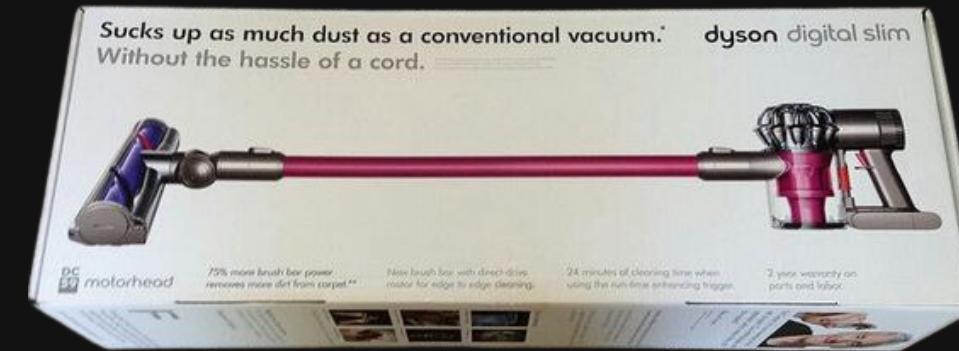
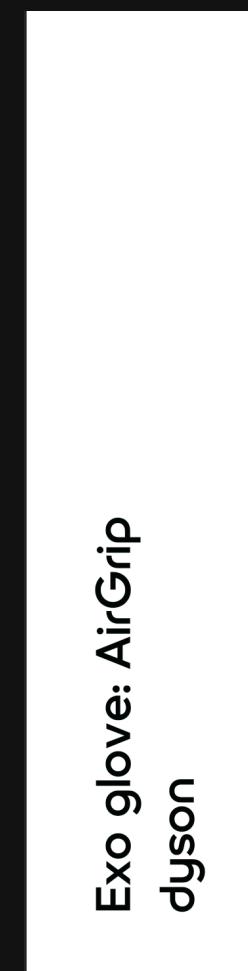
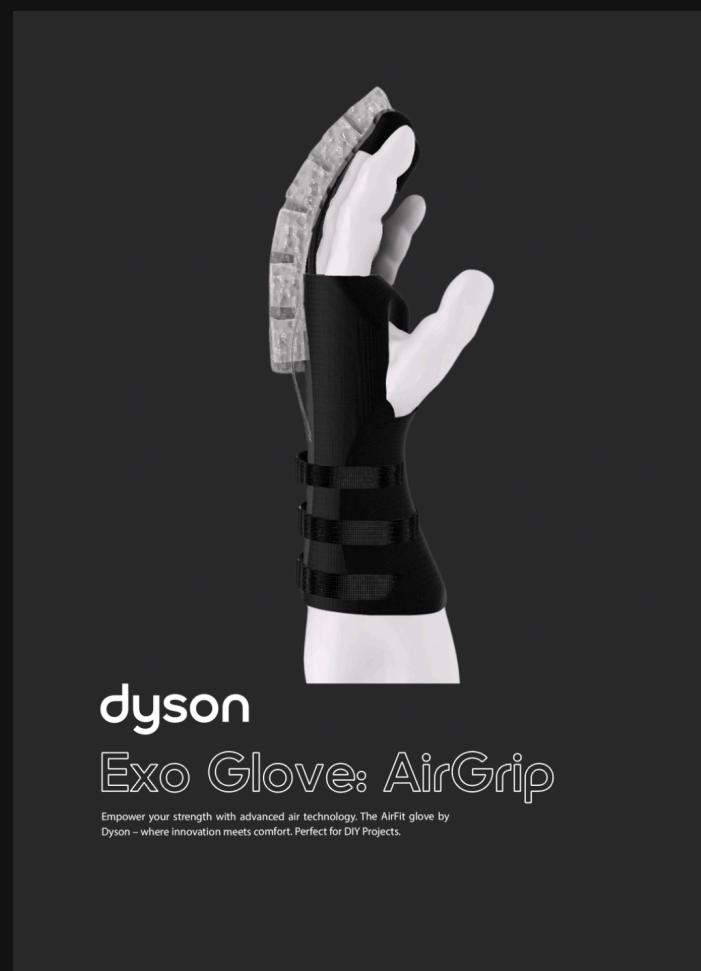
packaging

Inspiration

The Exo Glove packaging reflects premium quality and cutting-edge design, inspired by Dyson's latest trends, particularly their sleek black packaging from the Dyson Zone noise-cancelling headphones line. With the Exo Glove, Dyson is starting a new wearable line.

This approach diverges from Dyson's traditional white packaging, establishing a cohesive [visual identity](#). The black design enhances the product's premium look and highlights its technological sophistication, reinforcing Dyson's innovative and modern image.

Product labels



The black packaging of the Exo Glove exudes elegance and luxury, enhancing its perceived value with a striking contrast of black and white accents.

This design highlights key product information and aligns with consumer expectations for innovation and quality. The packaging features a close-up 3D model and the Dyson logo, with the slogan "Power in Your Hands: The Future of Wearables" on the back.

Measuring 750mm x 325mm x 140mm, the box includes reinforced pallets for strength and essential labels for compliance and sustainability. Made with [FSC-accredited uncoated paper stock](#), the design supports environmental responsibility and ensures product protection during transportation.

packaging

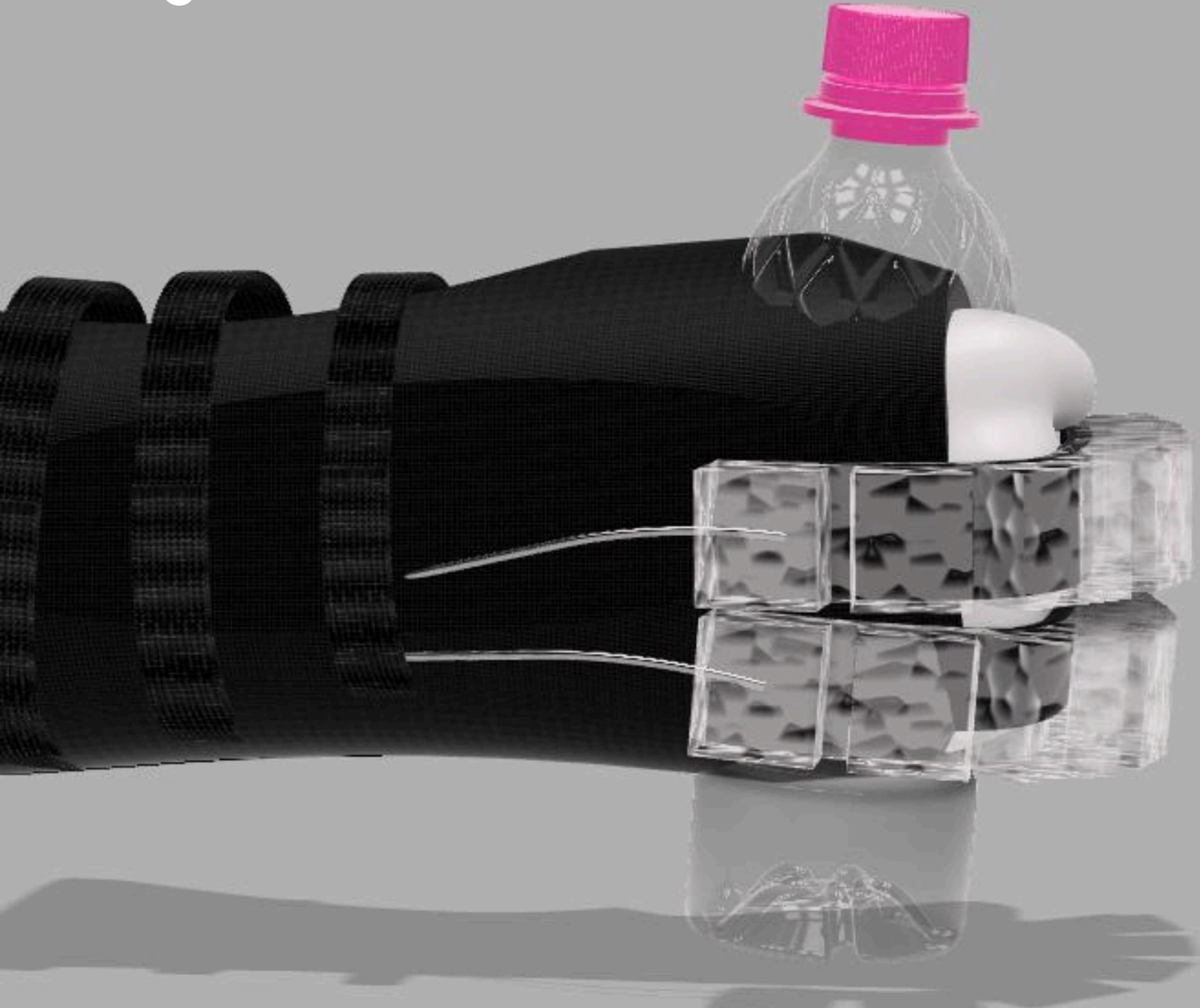
Visual render

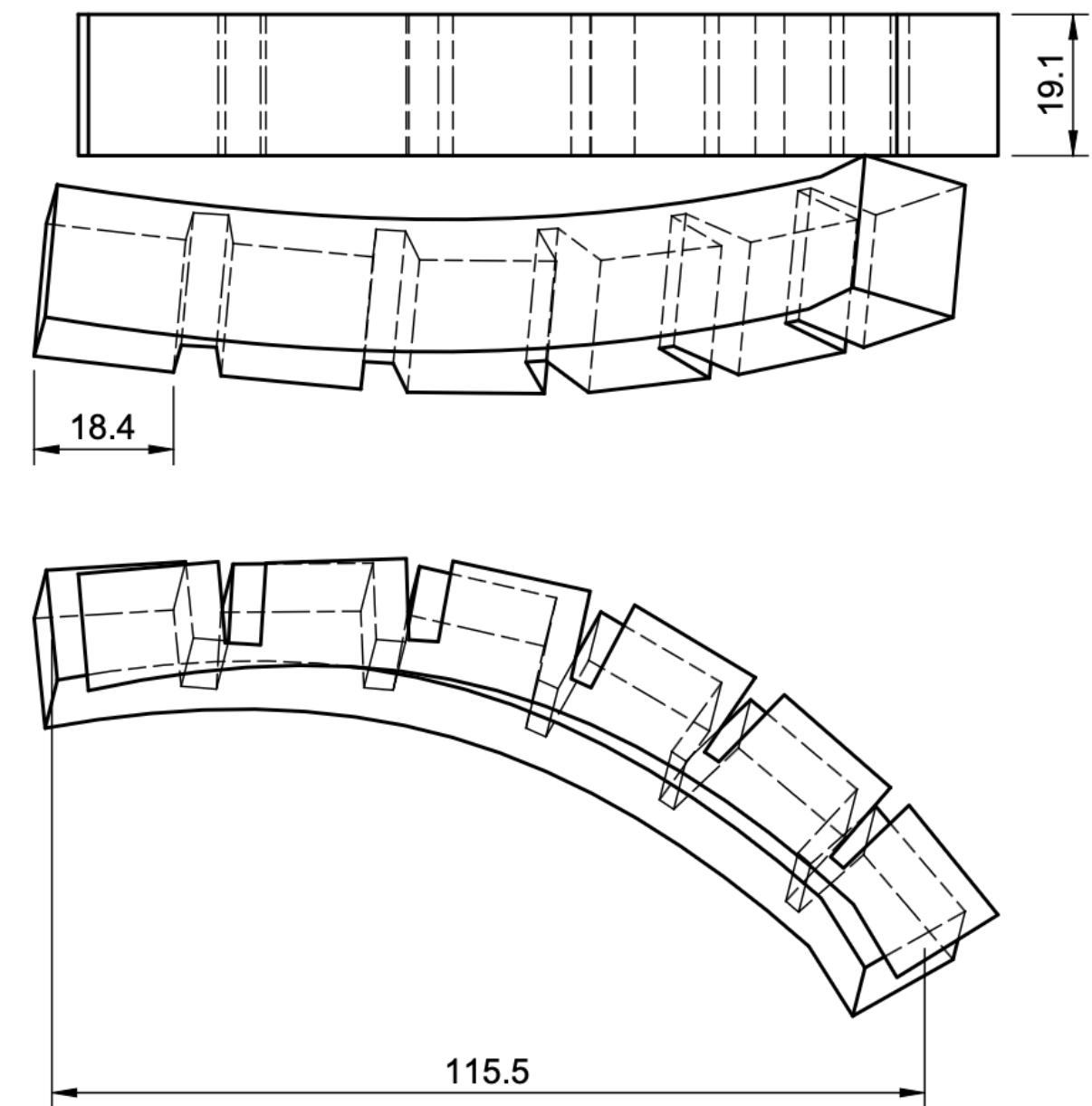


exoglove



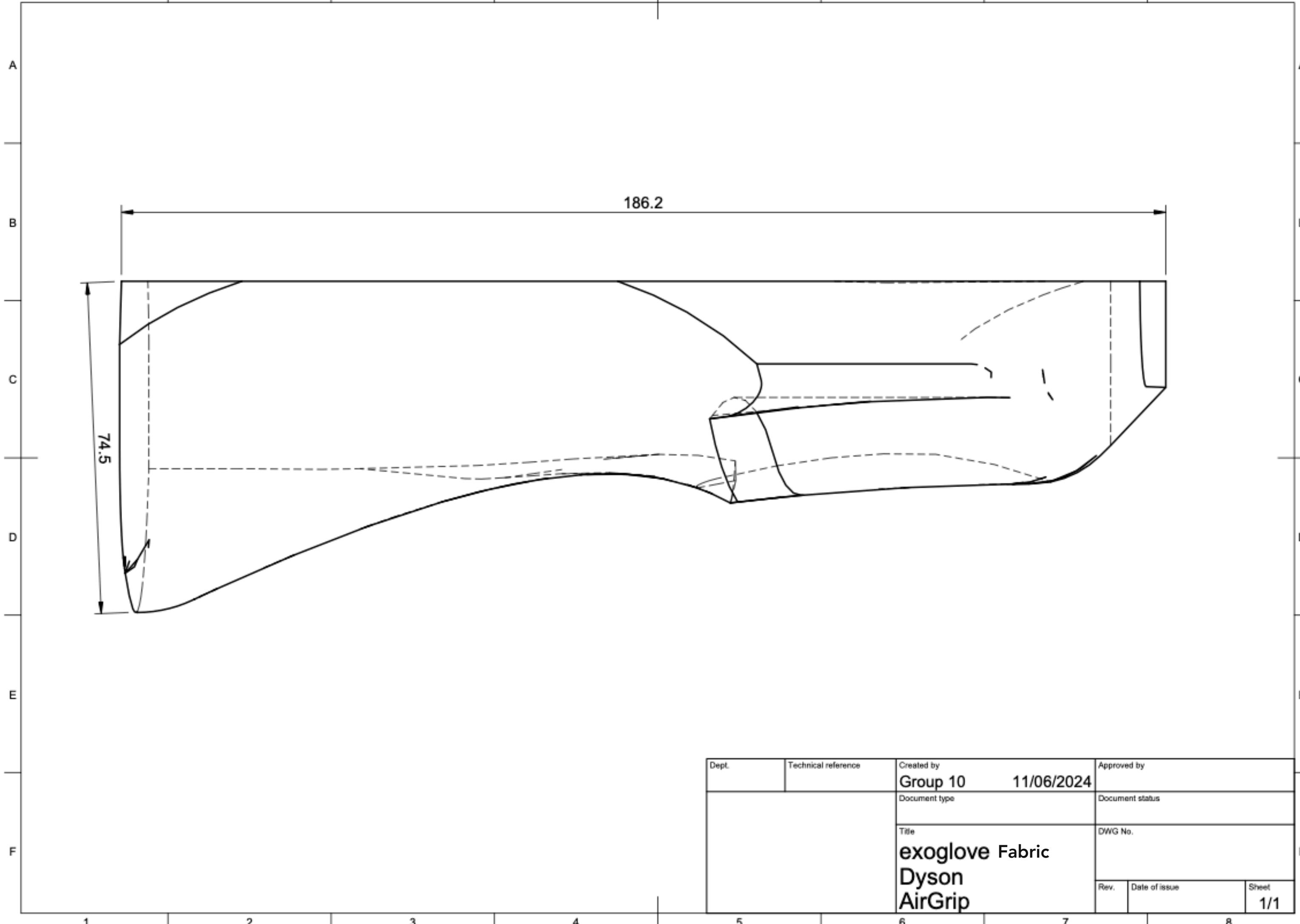
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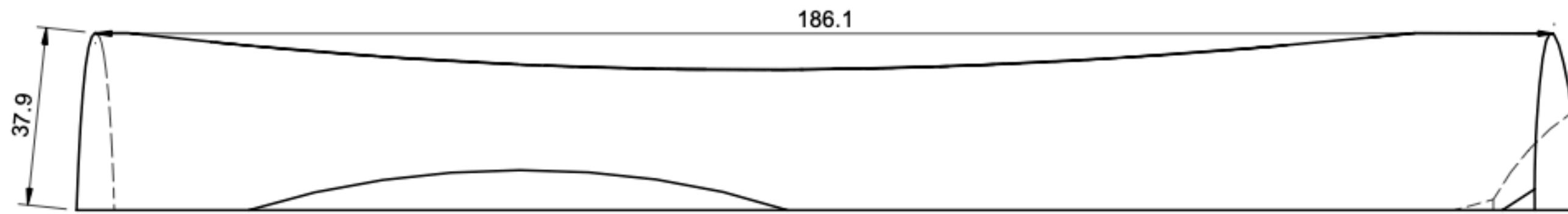
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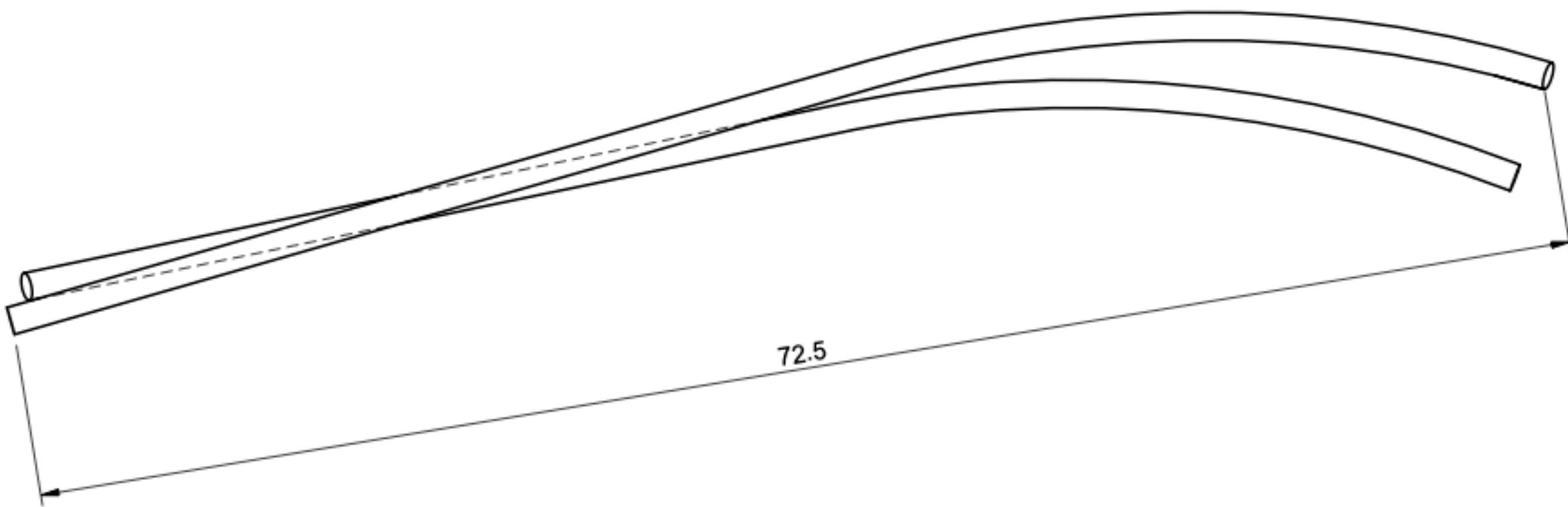
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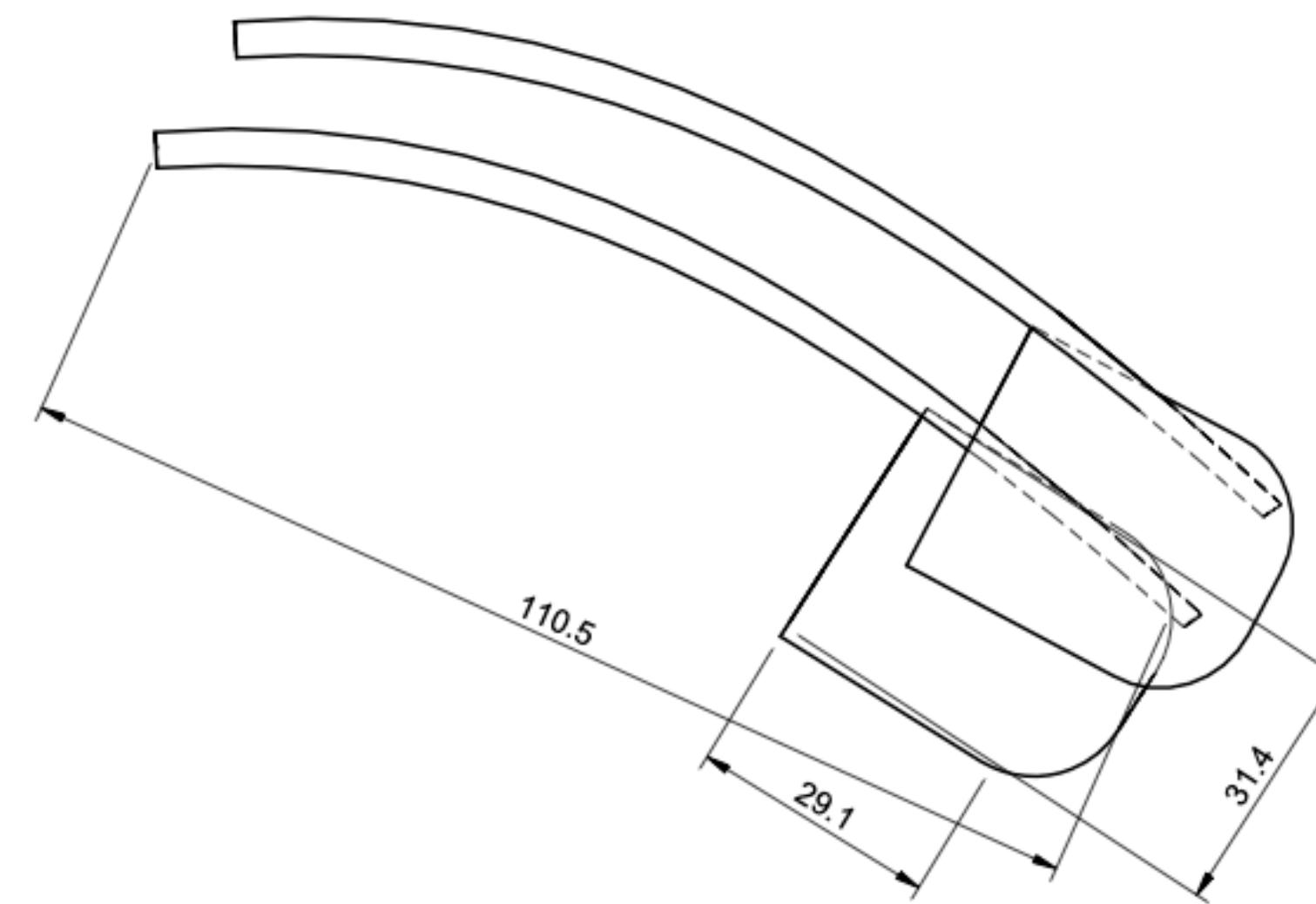


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Rev.	Date of issue	Sheet	1/1

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