Industrial design

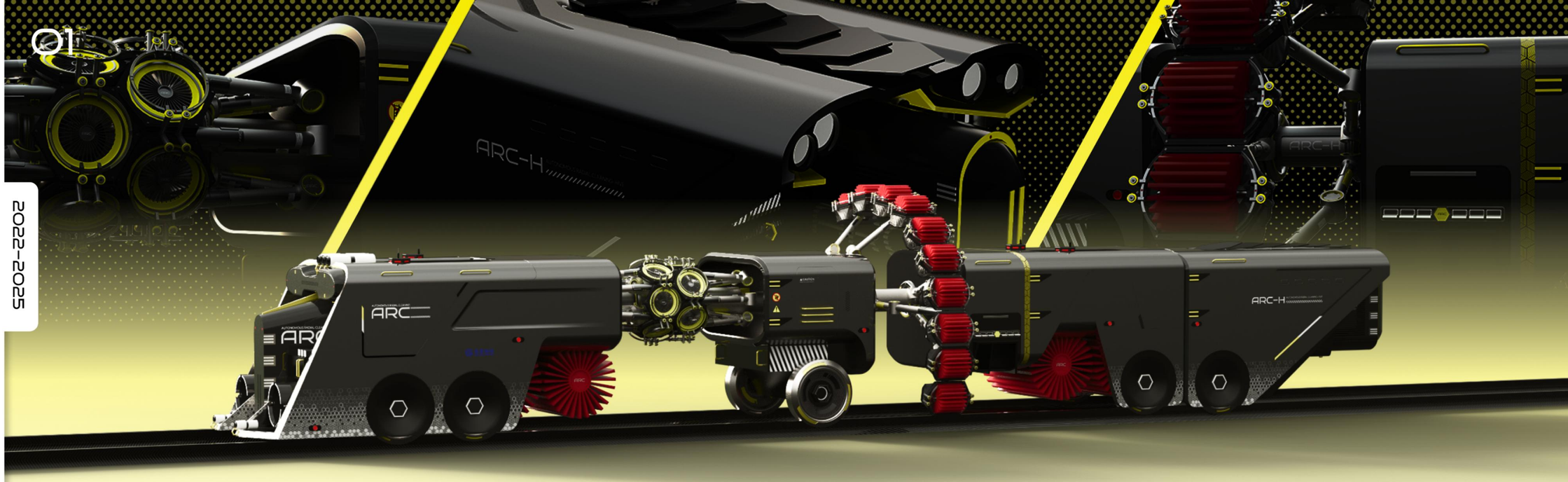
PORTFOLIO

2022-2025

NAME:
Xu haochen

VIDEO TASK LINK:
https://youtu.be/xy6nyZwjz-o

01



ARC-H 2024-2025

An **unmanned tunnel-cleaning vehicle** that replaces traditional manual workers, utilizing modular segmented carriages to enhance the logic of the cleaning process. It ensures the highest cleaning accuracy through honeycomb-shaped cleaning devices and mobile robotic arms, **freeing traditional subway cleaning workers from high-risk occupations.**

AUTONOMOUS RADIAL CLEANING-HIVE

BACK GROUND

PAIN POINT

▼// Unclean subway tunnels not only limit the visibility of subway drivers, but also seriously affect the air quality inside stations, tunnels, and subway trains, and impact the health of daily commuters. 01

▼// The efficiency of manually holding the spray gun is low, and the dark environment cannot guarantee that all areas are cleaned thoroughly. 03

▼// The poor air quality inside the subway tunnel is severely impacting the health of cleaning personnel. 02

▼// The cleaning vehicle has a large volume, poor flexibility, and high operational requirements for the cabin crew. 04

DATA ANALYSIS

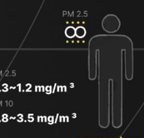
Vehicle cleaning efficiency
150-400m ²/min
calculated based on the tunnel circumference (approximately 25-35m ²/m) x speed

Manual cleaning efficiency
15-25m ²/min

PM 2.5/ PM 10

workers.

PM 2.5



PM 2.5
0.3~1.2 mg/m ³
PM 10
0.8~3.5 mg/m ³

commuters.

Tunnel section
35-65 μ g/m ³
Ground section
15-30 μ g/m ³

DESK RESEARCH

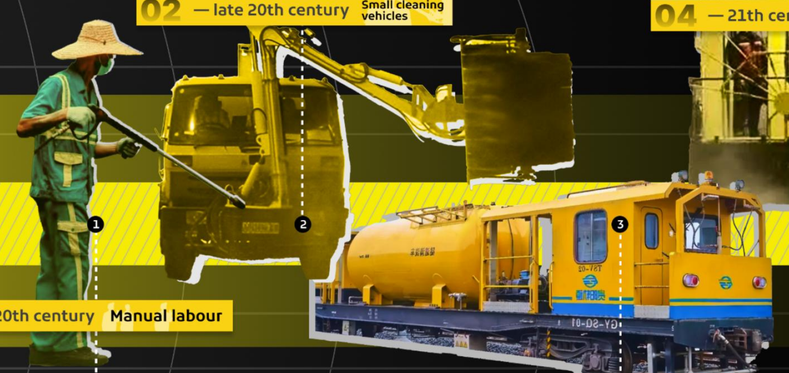
HISTORY

▼ Specialized small cleaning vehicles are available that can either operate along the tracks or be towed by locomotives. They are typically equipped with rotating cleaning brushes, although water gun flushing still relies on manual operation.

▼ These large cleaning vehicles integrate both washing and waste collection functions, and have been further developed to include additional features such as sewage recycling and storage. Simultaneously, most tasks that previously required manual labor have been automated, significantly reducing the need for human involvement.

02 — late 20th century **Small cleaning vehicles**

04 — 21th century **Automatic tunnel cleaning vehicle**



01 — mid 20th century **Manual labour**

▼ Workers use water pipes or high-pressure water guns to flush the tunnel walls and track areas, removing some dust and stains, and then cooperate with manual cleaning of accumulated water.

03 — 21th century **Artificial tunnel cleaning vehicle**

▼ The introduction of large cleaning vehicles has achieved the integration of washing and collection. Although manual water spraying and vehicle operation are still required, reliance on manual labor has been greatly reduced compared to the past.

Problem Statement

▼// How can we efficiently eliminate accumulated contaminants such as dust, sediment, metal powder, and oil stains from tunnel sidewalls, pipelines, trackbeds, and drainage ditches to significantly enhance air quality within tunnels, stations, and subway trains after cleaning, while maximizing automation to reduce cleaners' exposure to hazardous high-pollution work environments?

USAGE SCENARIO ANALYSIS

OPERATION TIME WINDOW

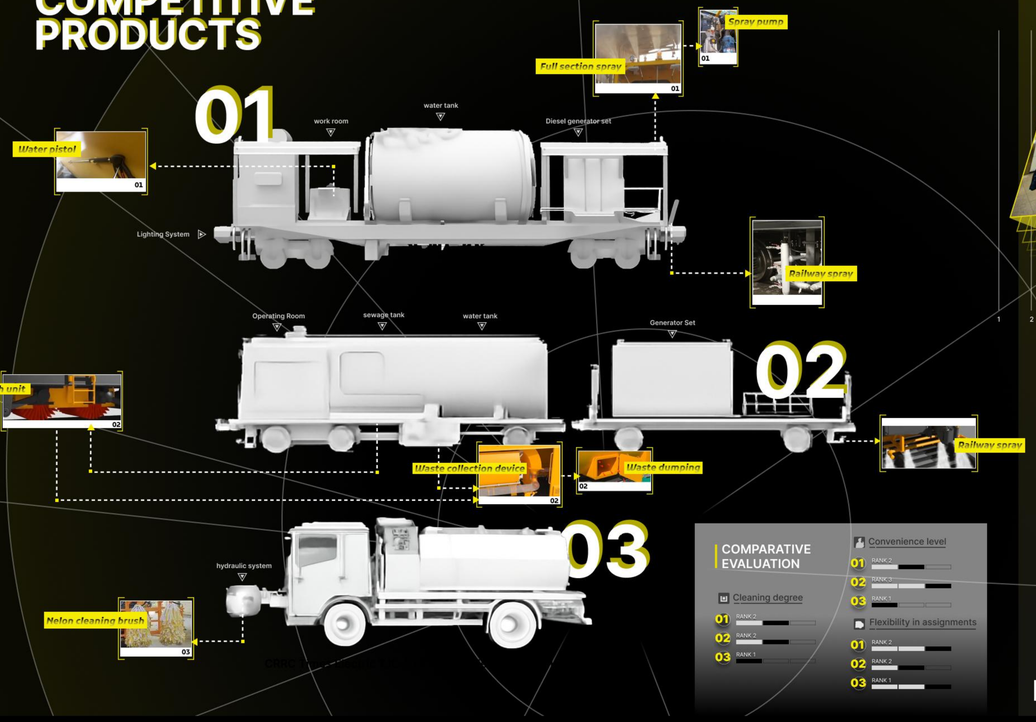
Skylight period nominal
23:00 pm -5:00 am
Only during the subway shutdown period

Single Task Duration
≤ 4 hours
(including tunnel entry and exit time)

CLEANING OBJECT TYPE

- **Hard attachments** — track rust/concrete dust (density 1.8-2.2g/cm ³)
- **Soft pollutants** — oily sludge (viscosity>5000cP), leakage water.
- **Special residue** — Brake metal powder (particle size<10 μ m), cable insulation debris.

COMPETITIVE PRODUCTS



01： Tangshan Baichuan Intelligent Machine Co., Ltd. - Subway Tunnel Cleaning Vehicle Series
02： CRRC Times Electric TJC-XXX Tunnel Cleaning Vehicle Series
03： Chengli Special Purpose Vehicle Co., Ltd. - Subway Tunnel Cleaning Vehicle

USER RESEARCH

FACE TO FACE INTERVIEW

In Haidian Huangzhuang Subway Station

XU HAOCHEN
Tunnel cleaning is not a well-known cleaning process in the subway. May I ask why tunnel cleaning is extremely important for subway passengers and how the dirt inside subway tunnels is formed?

SUN JIANFEI
Because subway vehicles entering the tunnel from the ground vehicle depot will bring in dust, cause air blockage forming particulate matter in the air, which will be concentrated at the environment on which it depends. Natural ventilation and drainage from subway operation sites, except for bathrooms, will eventually accumulate in the tunnel, producing sediment. Tunnel cleaning is aimed at improving the air quality inside subways and stations, and further enhancing the comfort of passengers while riding.

XU HAOCHEN
What are the advantages of using tunnel cleaning vehicles for cleaning compared to manual cleaning? When do regular cleaning vehicles start working in tunnels? Will it affect the normal operation of the subway.

SUN JIANFEI
Compared with using manual cleaning, tunnel cleaning vehicles only need about 1 operation point, i.e. cleaning the 519-kilometer-long line 11 calculated based on the working hours of 1:20 to 4:00 in the morning every day. Moreover, due to the high water pressure of the nozzle of the tunnel cleaning vehicle and its distribution at different angles, the cleaning is also cleaner.

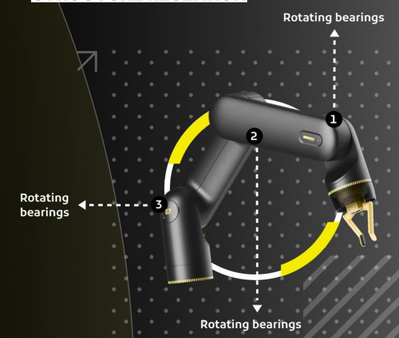
XU HAOCHEN
What difficulties did you encounter during tunnel cleaning before the popularization of subway tunnel cleaning vehicles?

SUN JIANFEI
Removing stubborn stains requires manual cleaning. During this process, maintenance personnel often become thoroughly soaked. Additionally, equipment in the tunnel must remain de-energized throughout the cleaning period. Once cleaning is completed, we also need to verify the power supply status to ensure normal subway operation.

August 7, 2025, Haidian Huangzhuang Subway Station, Haidian District, Beijing

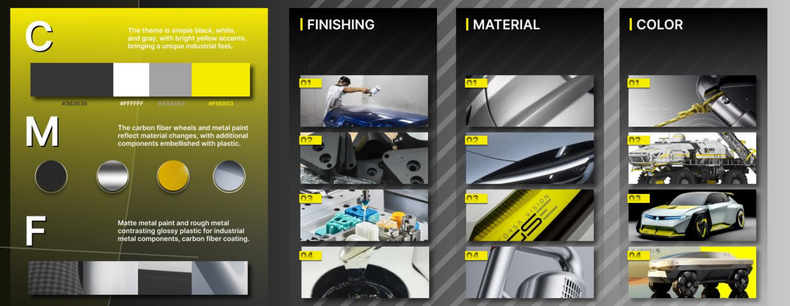
AUTONOMOUS RADIAL CLEANING
ARC

STRUCTURE RESEARCH



The circular arm can be deployed and stored using a minimal number of drivers. Its strengths include a stable structure with excellent rigidity, effectively resisting operational reaction forces; simple control logic, requiring only management of the retraction sequence; and high storage efficiency, allowing compact placement within the carriage. Furthermore, its fixed cleaning path ensures high reliability and predictable operation, while its standardized design reduces complexity, facilitates deployment, and lowers maintenance requirements.

CMF RESEARCH



COLOR 01, 04: Metallic color 02,03: Simple black, white, gray, and bright yellow accents.
MATERIAL 01: Carbon fiber 02: Metallic paint 03: Plastic 04: Metal
FINISHING 01: High-temperature baked paint 02: Clear varnish protective layer 03: Hard anodizing 04: In mold injection molding

TECHNOLOGY RESEARCH

Mature automatic subway

Existing unmanned subway cleaning systems follow fixed paths. To enable intelligent operation, the system fuses LiDAR point clouds, camera images, and millimeter-wave radar targets at the underlying layer to build an accurate environmental model. For example, LiDAR locates an object, the camera identifies it as a "toolbox," and radar confirms it is stationary. After independent sensor judgments, the fusion center synthesizes conclusions—such as determining a "passable puddle." This multi-sensor fusion transforms the system from a fixed-path executor into an intelligent platform capable of perceiving and responding to complex environments.

TYPES OF RADAR

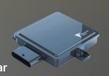
01 Forward LiDAR

Generate high-precision 3D point cloud maps by emitting laser beams and receiving reflected signals. Forward looking path planning and obstacle detection Build a precise model of the tunnel structure in front of the vehicle. Provide safe deceleration and braking distance for vehicle cruising.

02 Lateral LiDAR

Equipped with rotating components, it provides real-time high-precision distance measurement on both sides of the vehicle, ensuring the brush arm maintains the optimal cleaning distance from the tunnel wall. Identify cracks, dents, or protrusions on the tunnel wall and notify the main control system in advance to adjust the posture of the robotic arm to avoid collisions.

03 Millimeter wave radar



Detects objects through the Doppler effect by emitting radio waves in the millimeter wave frequency band. Strong penetration through harsh environments where optical sensors such as dust and water mist cannot work. Directly measuring the relative velocity with the object in front is crucial for determining whether there are personnel or vehicles entering. The detection effect of metal objects is excellent. Integrate with the main LiDAR and train head as redundancy and supplement.

DESIGN PROCESS

INSIGHT

- The high-pressure water gun has incomplete cleaning, low cleaning efficiency, and is prone to accumulating sludge that cannot be cleaned in corners.
- Not drying the sewage left after flushing can lead to many consequences, such as rusting of metal parts; Short circuit and malfunction of electrical equipment.
- Directly flushing with a spray gun will cause the existing dust in the tunnel to form silt. In the current plan, the silt needs to be manually collected by cleaning personnel.
- The cleaning vehicle has a large volume, poor flexibility, and high operational requirements for the cabin crew. Consuming manpower, poor air quality inside the tunnel, affecting the health of cleaning personnel.
- The situation inside the railway is complex, with many precision instruments and equipment that need protection, which can easily cause damage during the cleaning process

OPPORTUNITY

- Develop smarter and more efficient cleaning mechanisms to reduce sludge accumulation through preventive measures, thereby improving overall cleaning effectiveness and operational efficiency.
- The opportunity lies in deploying real-time environment awareness systems to enhance operational accuracy and security, and avoid damage to sensitive devices.
- The opportunity lies in integrating active drying technology to eliminate safety hazards caused by residual sewage, such as corrosion or slip risks, and ensure that the tunnel environment quickly returns to a dry state.
- The opportunity lies in designing modular and adjustable systems to enhance equipment flexibility and automation, reduce human dependence, and improve working conditions.
- The opportunity lies in introducing pre-processing steps at the front end of the cleaning process to reduce sludge generation from the source and avoid subsequent cleaning difficulties.

SOLUTION

- Achieve precise targeted flushing through auxiliary methods.
- Employ preliminary vacuuming to prevent sludge formation.
- Incorporate a drying phase following the overall cleaning process.
- Expand and diffuse the cleaning direction to increase spray coverage.
- Enable flexible adjustment of train carriages based on operational needs.
- Utilize LiDAR for real-time railway monitoring, eliminating the need for auxiliary drivers.

FINAL CONCEPT

RADAR—GUIDED CLEANING

LiDAR and millimeter-wave radar are employed to accurately identify debris and track conditions, ensuring cleaning integrity and enabling unmanned operation of the cleaning vehicles.

STRETCHABLE BODY

The carriages can be separated and reassembled, with operational positions dynamically adjustable to ensure normal operation while allowing the modular hive-shaped cleaning devices inside to be retracted and deployed flexibly.

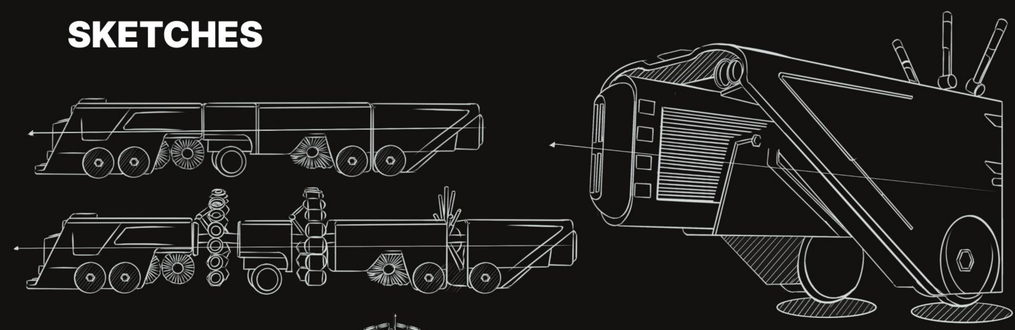
MODULAR CLEANING DEVICE

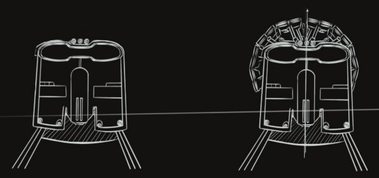
The honeycomb-shaped modular cleaning device can be extended to achieve full circular coverage of the tunnel, ensuring high cleaning completion, while also retracting into the carriage for wastewater recovery.

COMPLETE CLEANING LOGIC

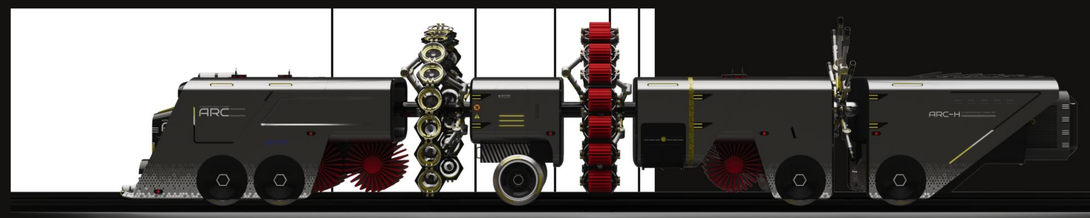
The four carriages sequentially execute a complete cleaning logic —master control, vacuuming, brushing, spraying, and drying—to achieve optimal efficiency and thoroughness in cleaning operations.

SKETCHES





FINAL DESIGN



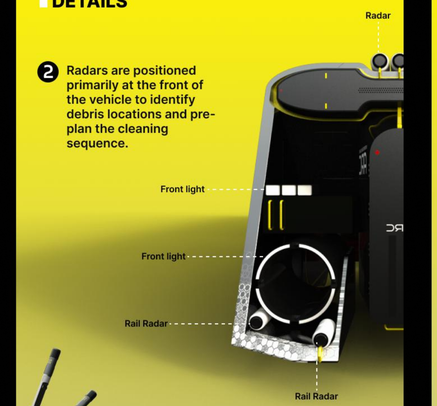
DETAILS

CLEANING DEVICE

1 A honeycomb-shaped modular cleaning assembly connects two cleaning units (depicted as vacuum units) via a robotic arm. The arm's movement enables retraction and extension of the cleaning units, achieving radial coverage. Warning lights are also integrated into the device for both alerting and illumination.

CAR-BODY DETAILS

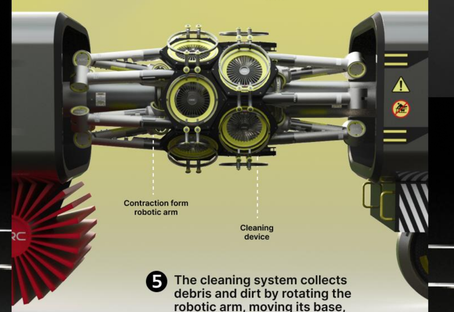
2 Radars are positioned primarily at the front of the vehicle to identify debris locations and pre-plan the cleaning sequence.



3 A rear-mounted suspension drying unit performs overall drying after the preceding three stages—vacuuming, brushing, and spraying—are complete.

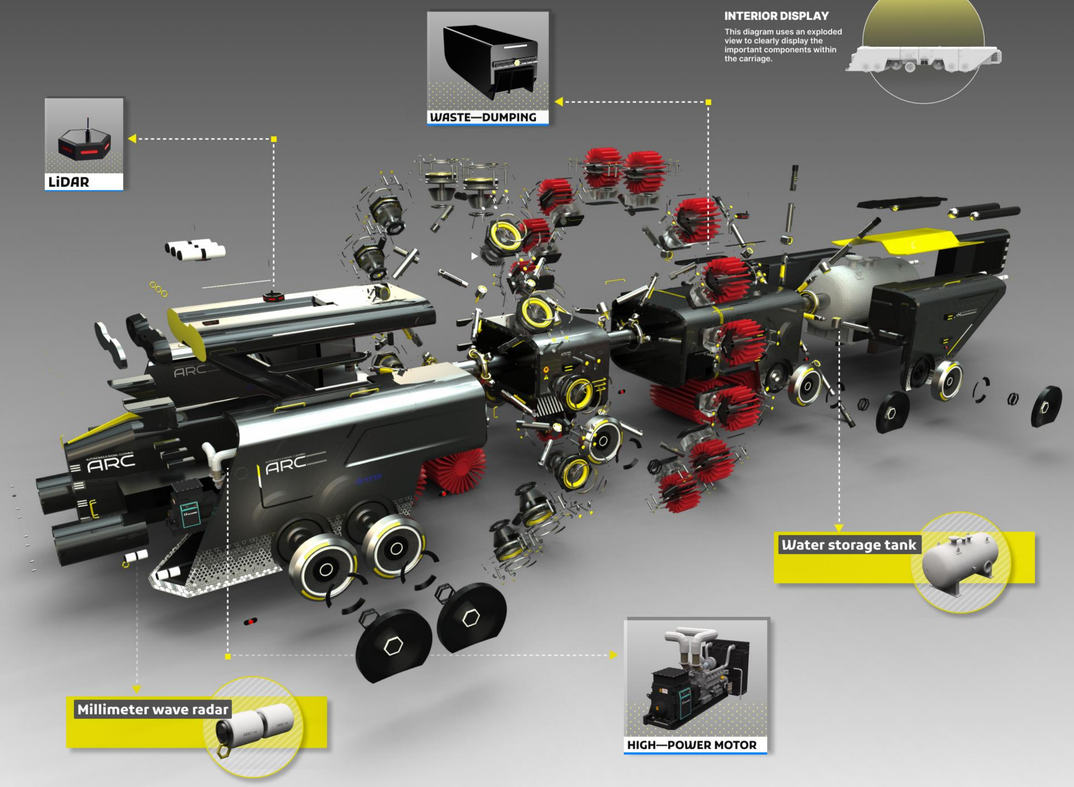
DEVICE DETAILS

4 The cleaning assembly covers the tunnel's full cross-section through coordinated rotation, extension, and base movement of the robotic arm.



5 The cleaning system collects debris and dirt by rotating the robotic arm, moving its base, and retracting the assembly back into the carriage.

EXPLODED VIEW



RENDERINGS

RENDERINGS

AUTONOMOUS RADIAL CLEANING
ARC

The last subway train running at 11:00 pm has been suspended, and the ARCH tunnel cleaning vehicle is about to start its cleaning.

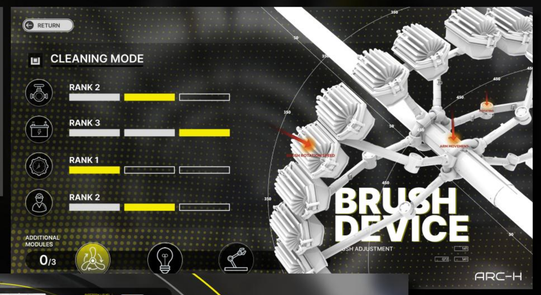
INTERFACE DISPLAY

▲ The login interface of ARCH tunnel cleaning vehicle control app.

01

The secondary interface of the main interface. Click "BRUSH" from the main interface to adjust the specific values of the cleaning vehicle's spray module, such as Brush rotation speed, brush position, etc.

03



The secondary interface of the main interface. Click "Spray" from the main interface to adjust the specific values of the cleaning vehicle's spray module, such as water pressure, spray position, etc.

03

The main interface of the interface can complete the supervision of train conditions and the identification of tunnel radar scanning results and types of dirt and stains.

02

During the cleaning vehicle's operation, workers remotely control it from the central console, supervising and enabling it to complete the cleaning process either autonomously or via manual intervention.

STORY BOARD

This storyboard illustrates the complete workflow of the cleaning vehicle from tunnel entry to exit, demonstrating how thorough tunnel cleaning and waste recycling are achieved through ARCH's specialized design.

1. Radar
2. Contaminantsy
3. Robotic arm—— contraction
4. Robotic arm—— unfolded

03 — Cleaning device fully unfolded

Fully unfold the vacuum cleaner, brush, and water spray cleaning devices stored in the carriage, and complete deep cleaning according to the previously planned plot logic based on scanning.

04 — Retract the cleaning device.

After the cleaning device is retracted into the vehicle and linked between the carriages, it is cleaned inside the carriage while dust and sludge remaining in the device are recovered. Once the cleaning operation is completed, workers can collect and recycle debris from the waste disposal module outside the vehicle body.

02 — Cleaning device unfolded as needed

Before reaching the scanned dirty location, according to the planned cleaning logic, continuously deploy the vacuum cleaner, brush, and water spray vacuum cleaner for the interior storage of the carriage as needed.

01 — Scanning for contaminantsy

The radar scans the dirty areas inside the tunnel in seconds, confirms the location and type of dirt, and plans the cleaning sequence.

ARC-H

02

STORY WEAVER

2024-2025

—— AI interactive projection medical device

This project introduces a **"Creative Healing" system** for hospitalized children. It uses **hand-shadow recognition** and a simple dial interface to capture creative input, which **AI then converts into personalized stories**, giving children a sense of control. The system also establishes an emotional support loop through a story gallery and a family app, **creating a supportive haven** within the hospital environment.

INSPIRATION

Two years ago, my younger sister struggled with a serious illness. Because our family was tied up with other responsibilities, she often had to stay in the hospital on her own for treatment. Later, she told me how hard it was to be alone in her room — how lonely and scared she felt most of the time. Back then, I wished that even if she was in a quiet ward by herself, she would never have to feel alone again.

BACKGROUND

Psychological pressure is widespread:

- hospitalized children generally face severe feelings of loneliness, fear, and anxiety.

The proportion of hospitalized children showing significant anxiety :

The proportion of hospitalized school-age children whose primary source of stress is fear of separation from their parents :

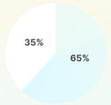
Shortcomings of existing solutions:

- The hospital's existing entertainment measures (such as television) have limited effectiveness and lack solutions that can provide personalized support and creative expression.

Ward time blank:

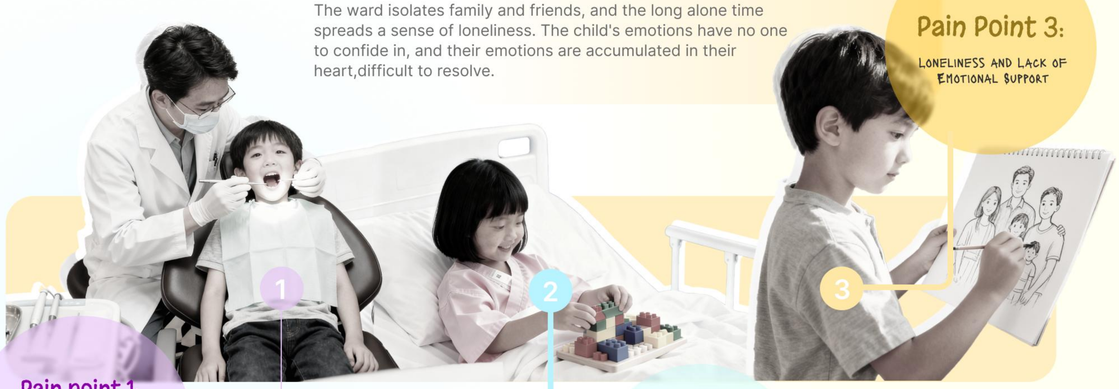
- Children have a lot of boring and unstructured alone time in the ward and urgently need active intervention.

The duration of unstructured activities for hospitalized children in the ward:



PAIN-POINTS

The ward isolates family and friends, and the long alone time spreads a sense of loneliness. The child's emotions have no one to confide in, and their emotions are accumulated in their heart,difficult to resolve.



Pain point 1:

FEELING OF BEING AFFECTED AND LOSING CONTROL IN A MEDICAL ENVIRONMENT

In the hospital, everything for children is decided by adults, from treatment to sleep, and personal will is completely deprived. This sense of loss of control will exacerbate their anxiety and fear, making them feel helpless.

Pain Point 2:

LACK OF CREATIVE EXPRESSION AND POSITIVE ACTIVITIES.

The ward environment is monotonous, and traditional entertainment is mostly passive consumption, which cannot satisfy children's natural desire for creativity and exploration. This leads to mental fatigue and deep boredom.

Pain Point 3:

LONELINESS AND LACK OF EMOTIONAL SUPPORT

PROBLEM STATEMENT

Hospitalized children face profound loneliness and fear, as existing passive entertainment fails to support their need for active, creative expression—reducing them from “active individuals” to “passive patients.” An innovative solution is urgently needed to restore their creative agency and alleviate emotional isolation.

BRAND-ANALYSIS

轻松健康集团 QingSong Health

Qingsong Health Group is an AI-powered, one-stop health platform. With a mission to empower families against illness, it offers both Digital Health and Health Insurance services to its 168 million+ users, covering needs from education and screening to management and protection.

“Children's Health Care Outreach” Activity

“Qingsong Growth” Child Health Initiative

“Ward Library” Project

CASE-STUDY

ROPET

A desktop static companion robot. Equipped with temperature simulation, by recording the host's emotions and behaviors, seeking interaction at appropriate times (such as seeking touch), emphasizing the weak companionship and emotional empathy of being needed, without relying on dialogue.

169$

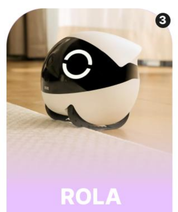
Empathy | Comfort

DOKIDS

A companion smart robot designed for children aged 3 to 12, positioned as an “electronic pet.” It simulates a sense of life through an LED expression screen, extendable front feet, and touch interaction. Its core functions include habit formation and remote parental supervision/ communication.

212$

Management | Cultivation

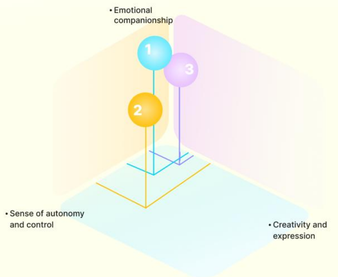


ROLA MINI

A mobile desktop robot that can be remotely controlled. The core is to serve as a “substitute” for remote interaction, allowing parents to interact with their children in real time and observe the environment through the robot's camera and microphone, achieving “physical remote companionship”.

283$

Connection | Communication



Analysis shows competitors are weak in creative expression and autonomy:

- Dokids = Semi-passive management.
- Ropet = Passive emotional soothing.
- Rolamini = Remote monitoring/receiver.

I expect my design to fills this gap through **“from creation to generation”** interaction, transforming children from **passive** patients into **active creators**, directly addressing their need for expression and control as a core competitive advantage.

INTERVIEW

01 Hospitalized Children - Xiaoyu — Hospitalized for one week due to fracture

A: It's boring to be alone and a bit scared. I miss my family very much, but I know they don't have time to be with me all the time. I can only pass the time by myself.

Q: What is the most difficult thing to endure in the hospital?

Q: What are the main difficulties currently faced in taking care of children's emotions?

Work for 8 years — Pediatric nurse - Nurse Zhang

A: Our manpower and time are limited, so we cannot be with every child all the time. There is a lack of activities in the ward that can encourage them to actively engage and forget their fears.

03 Parent - Ms. Li — Busy with work, child hospitalized

A: I hope to see him happy and energetic, not just knowing his condition. I want to talk to him about specific things instead of always asking 'does it hurt?'

Q: What do you most hope for when you are not with your child?

PERSONA

INFORMATION

Core portrait:
7 years old, hospitalized for fracture

Identity:
First grade boy, lively and active

Hospitalization status:
Hospitalized for 3 days, expected to be hospitalized for another 4-5 days

Accompanying situation:
Mother works during the day and accompanies at night; My father works in another city

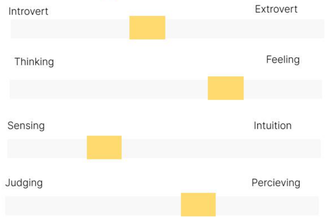
Strong sense of environmental unfamiliarity

Daily routines are broken

Dual physical and psychological pressure

Sudden interruption of social interaction

Personality



Needs

- **Emotional Support**
  To receive companionship and have their feelings acknowledged, especially when family is absent.
- **Self-Expression**
  A safe outlet to express fears and imagination, proving they are “more than just a patient”.
- **Regaining Control**
  The desire to make choices and experience mastery (“I can do this”) within a restricted environment.
- **Maintaining Connection**
  To sustain an emotional bond with family and have indirect interaction with peers.

Pain Points

- **Loneliness & Boredom**
  Long, solitary hours with few engaging activities.
- **Fear & Anxiety**
  Mounting fear of treatments with no emotional outlet.
- **Loss of Control**
  No autonomy over their daily routine or choices.
- **Stifled Creativity**
  Monotonous environment with no way to express themselves.

Nai-nai

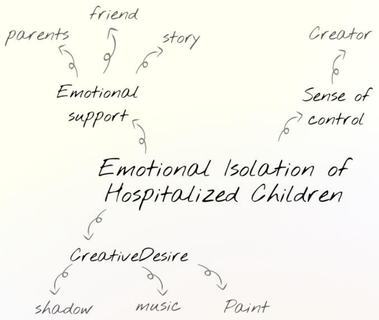
MIND MAP

Smart Creative Canvas

- Focus: Planar static expression
- Limitation: Lacks dynamic narrative and deep interaction

AR Magic Picture Book

- Focus: Blended virtual-real story experience
- Limitation: Relies on headset / Individualized / May exacerbate isolation



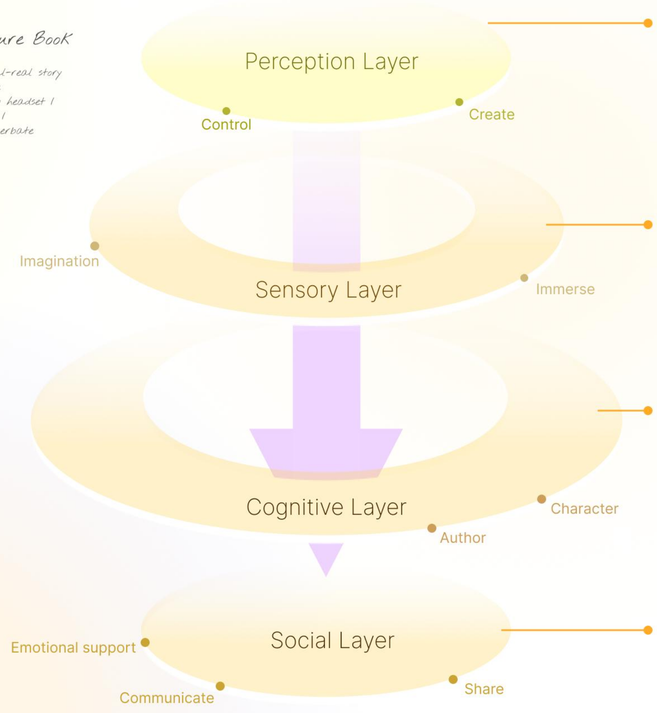
AI Light & Shadow Theater

- Technical Integration of Solution E: Projection + AI + Dial Interaction
- Core Advantages: Low cost, easy deployment / Group-viewable / Encourages active creation

Smart Creative Canvas

- Focus: Planar static expression
- Limitation: Lacks dynamic narrative and deep interaction

DESIGN CONCEPT



Creative Physical Expression: Shadow Recognition and Dial Control

- The device uses a camera to capture the child's **hand shadow** as a primal, direct creative input. The physical dial offers tactile feedback and a sense of choice. This layer transforms **body movement** into a starting point for **creation**, giving the child an initial feeling of control.

XR Visual Magic and Immersive Storytelling: Real-time Projection "Activation" & Immersive Story World

- The core AI technology acts as a **"visual magic"**, instantly transforming the hand shadow on the wall into a **unique animated character** within a dynamically generated story scene. This immediate, magical feedback creates a powerful flow experience, diverting the child's focus from the ward to a **self-initiated**, wonderful imagined world, enabling a positive **emotional escape.**

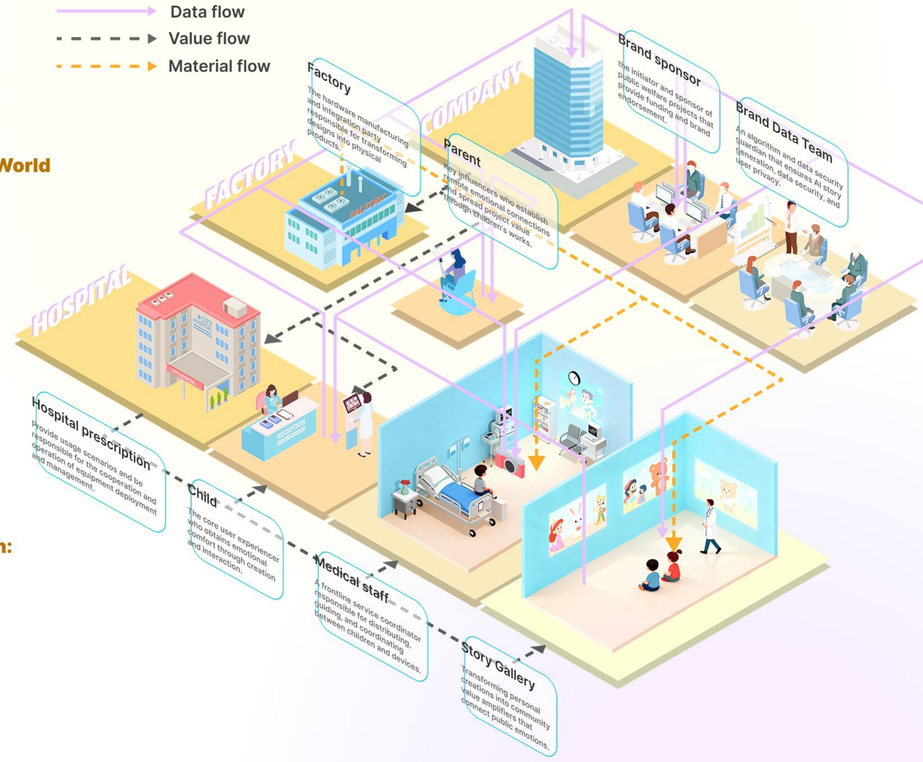
Guided Imagination and Cognitive Reframing: AI-Generated Narrative & Character Identification

- The system dynamically generates personalized narratives from the child's shadow character. The child shifts from being a **"patient"** to a story's **"co-author"** and **"hero"**. Plotlines involving overcoming challenges provide metaphorical empowerment. This helps translate real-life helplessness into narrative courage and confidence, fostering a **positive self-perception**.

Community Display and Family Emotional Connection: Story Gallery and Family App Synergistic Support

- The design builds two layers of social support. The **"Story Display Gallery"** turns individual creations into **shared assets for the ward community**, fostering belonging through recognition. Simultaneously, a Family App creates an **emotional bridge**, allowing care to connect directly to a child's creations via likes and voice messages, **enabling remote companionship through positive shared content.**

SYSTEM MAP



BUSINESS MODEL CANVAS

7 Key Parteners

- **Funders:** Corporations providing funding and branding.
- **Implementers:** Hospitals providing the clinical setting.
- **Supporters:** Psychologists, academic institutions, NGOs.

5 Key Activities

- **R&D:** Hardware & AI content iteration.
- **Operations&Service:** Deployment, training, maintenance.
- **Partnership&Impact:** Relationship management, research, communication.

6 Key Resources

- **Physical:** Custom hardware & servers.
- **Intellectual:** AI algorithms, story engine, database.
- **Relational:** Trusted partnerships with hospitals, brands, and experts.

4 Value Propositions

- **For Children:** A safe, creative outlet for emotional expression and stress relief through personalized storytelling.
- **For Hospitals:** An innovative, non-pharmacological intervention to enhance care quality and patient satisfaction.
- **For Brands:** A tangible CSR showcase demonstrating "Tech for Good".

2 Customer Relationships

- **Co-creation:** With children (stories) and hospitals.
- **Long-term Partnerships:** Ongoing service agreements with partners.
- **Community:** Built via the Story Gallery and parent app.

3 Revenue Streams

- CSR Procurement
- Donations & Story Sponsorship
- Premium Services (Future)

1 Customer Segments

- **Core Users:** Hospitalized children (3-12), especially long-term patients.
- **Key Customers:** Children's hospitals/pediatric wards.
- **Influencers:** Patients' parents/families.

8 Cost Structure

- **Fixed Costs:** R&D, hardware production, core software.
- **Operational:** Cloud services, maintenance, content update, staffing.
- **Expansion Costs:** Outreach, partnership development, research.

9 Revenue Streams

- **CSR Procurement:** Primary model (one-time/ annual fee from partners).
- **Donations & Story Sponsorship:** Public micro-donations for specific causes.
- **Premium Services (Future):** Custom solutions for private healthcare providers.

SKETCHES & FINAL DESIGN

Style Wheel

Style Wheel

Children can rotate the turntable on the device to choose their favorite story style.

Projection module

Children can project their created stories from projection module onto the walls of the ward.

Folding bracket

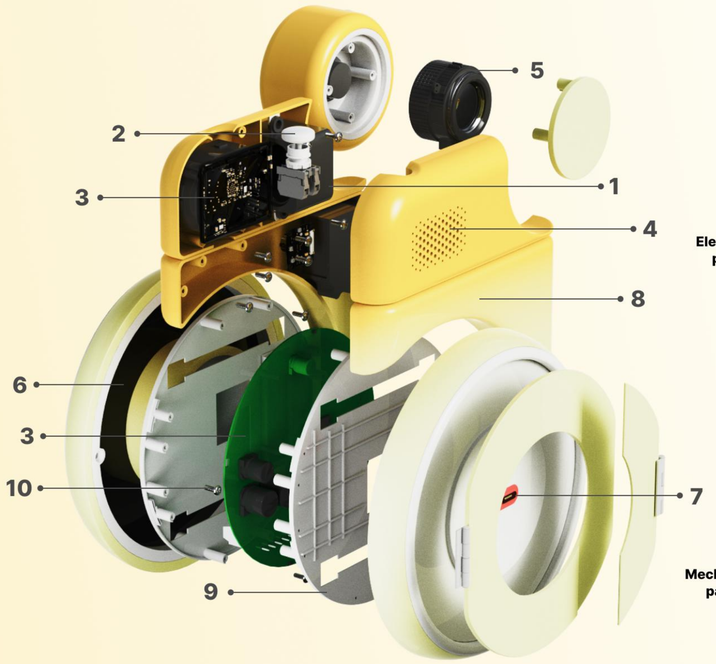
Instructions for use

Children can use the projection device by rotating the rotating module and unfolding the folding bracket to place the projection device in any position and project it to any location in the ward.

Rotating module

Children can choose the direction of their projection by rotating the steering module on the device.

Explored view



Material & Manufacture & Costing

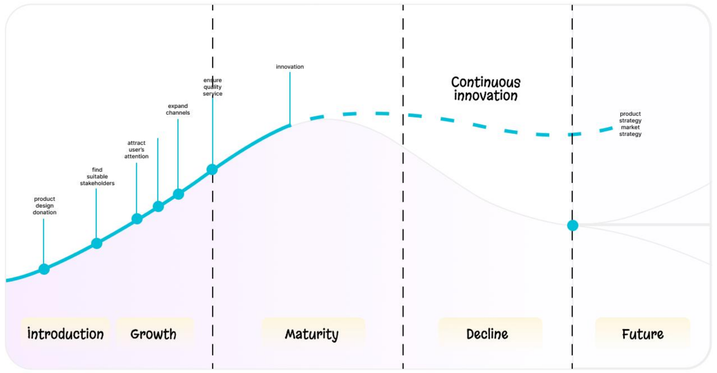
Cost

	Function block	Specifications/Materials	Price (€)	Reference brand/Plan
Electronic parts				
1	Projection unit	DLP micro projector 0.2 "DMD, resolution 854×480, brightness 80-100 ANSI lumens	17.5-21.5	Texas Instruments (TI) DLP solution as the core
2	Incremental rotary	encoder with down button function	0.8-1.7	ALPS or HUANO.
3	Intelligent Projector Board	Four core ARM CPU, 2GB RAM, 8GB eMMC, integrated Wi Fi/Bluetooth, audio amplifier, supports DLP/LCOS optical driver	9-11.5	Amlogic or Rockchip
4	Micro Speaker	1W, 4 Ω 5-8	1.1	Changzhou Wanshisheng Electronics Co., Ltd
5	camera module	300000 pixels, USB interface, fixed focal length 10-15	2.6-4.3	OmniVision or GalaxyCore sensor
6	Circular TFT LCD Screen	Circular, ~2-inch diameter, low resolution	11	DisplayMan
7	Type-C PD charging module	supports 12V/2A input	0.43-0.68	adopt mature PD deception chip solutions.
Mechenical parts				
8	Main shell (upper/ lower cover)	materials: ABS+PC, flame-retardant V0 level. The surface has a matte fine texture. Injection molding is required.	0.9-1.3	Zhuhai Feilida Electronics Co., Ltd
9	Internal structural components	ABS material. Including motherboard bracket, battery compartment, optical mounting bracket, etc.	0.9-1.3	Zhuhai Feilida Electronics Co., Ltd
10	screws, rubber pads	stainless steel, silicone	0.25	Pengchi Hardware Products Co., Ltd. (EG)

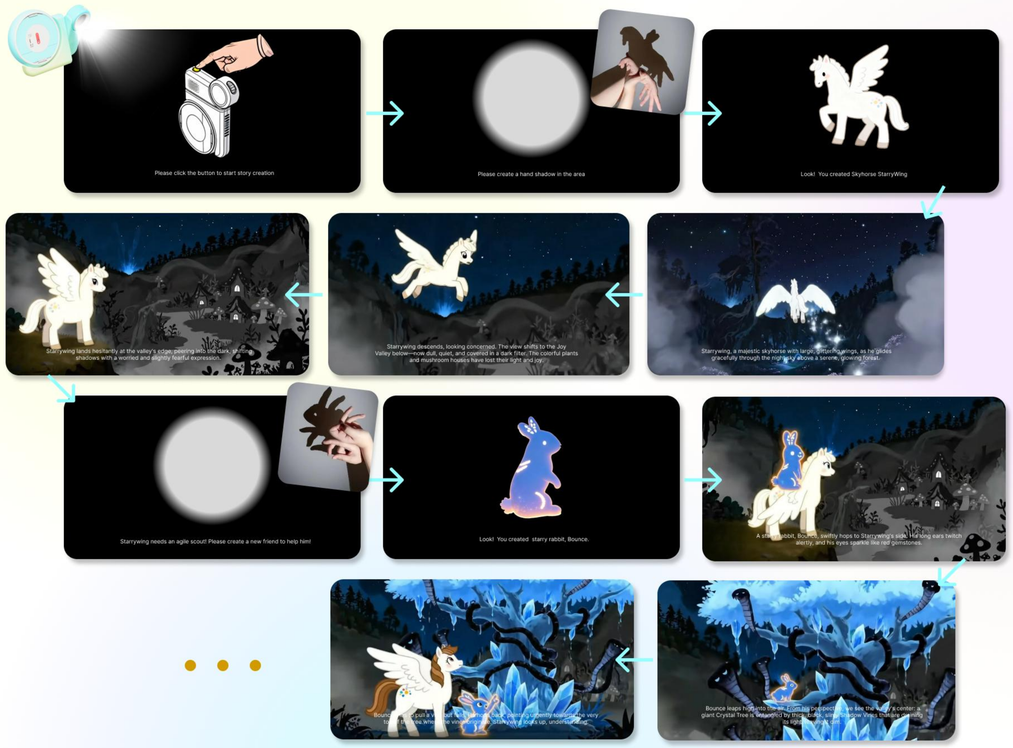
TOTAL=**44.5€**

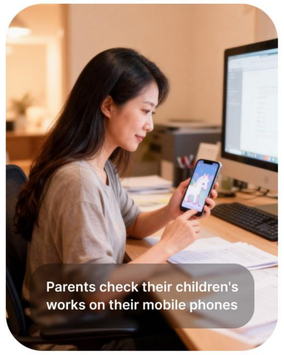
Product pricing

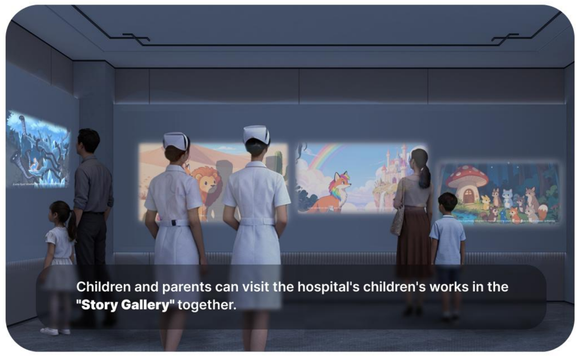
Product life cycle



Projected Content Display







SERVICE FLOW CHART

1 Public Welfare Initiatives and Funding

- Front stage

  The hospital warehouse administrator signs for the goods; Medical staff see installed equipment in the ward or activity room.

- Back stage

  The hospital warehouse administrator signs for the goods; Medical staff see installed equipment in the ward or activity room.

2 Device Manufacturing & Integration

- Front stage

  (This stage is invisible to users, as it is a preparatory phase.)

- Back stage

  The factory procures raw materials; the production line assembles the hardware; software engineers flash and test the AI story-generation system; the quality control department conducts final inspections and packaging.

3 Hospital Receiving & Deployment

- Front stage

  Hospital warehouse staff sign for the delivery; medical staff see the installed devices in wards or activity rooms.

- Back stage

  The hospital logistics department verifies device quantity and models; the IT department connects devices to the hospital's internal network; the nursing department establishes usage and management protocols.

4 Device Lending & Guidance

- Front stage

  A child receives the device from a nurse; the nurse demonstrates to the child and parent how to power it on and create hand shadows; the child returns the device to the nurse's station after use.

- Back stage

  Medical staff manage the device loan/return log; regularly clean and disinfect the devices; check battery levels and operational status to ensure readiness for the next user.

5 Creative Interaction & Story Generation

- Front stage

  The child makes a hand shadow; the camera captures the silhouette; the projector instantly "animates" the shadow into a character; the child watches and listens to the AI-generated personalized story.

- Back stage

  Medical staff manage the device loan/return log; regularly clean and disinfect the devices; check battery levels and operational status to ensure readiness for the next user.

6 Story Gallery — Offline Exhibition

- Front stage

  Visitors and patients watch curated animated stories on screens in the "Story Display Gallery"; each story is labeled with the hand-shadow character and a synopsis.

- Back stage

  Hospital volunteers or Child Life specialists select suitable works from the story library for public display; the communications department manages exhibition space setup and content updates; the technical team ensures stable operation of playback equipment.

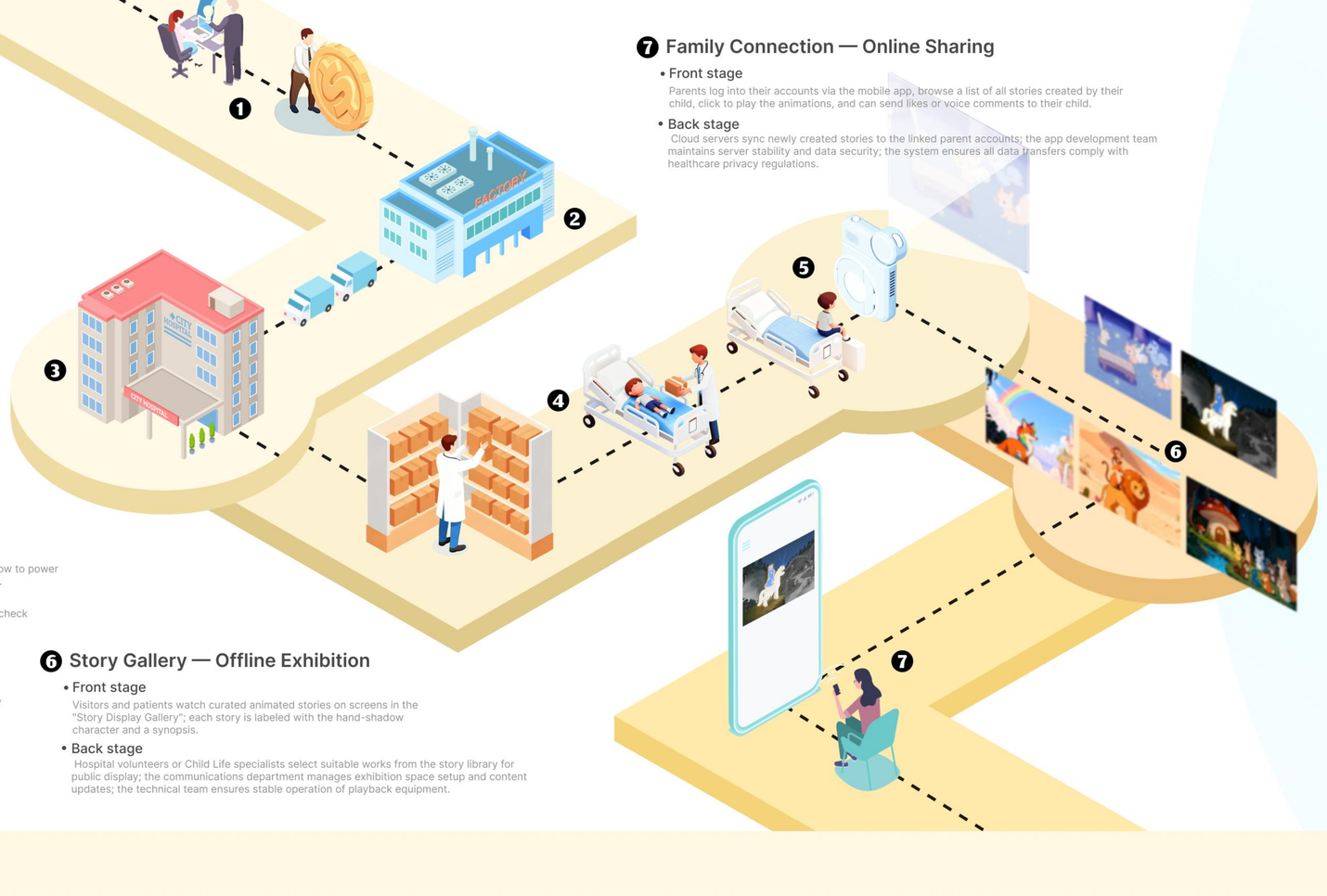
7 Family Connection — Online Sharing

- Front stage

  Parents log into their accounts via the mobile app, browse a list of all stories created by their child, click to play the animations, and can send likes or voice comments to their child.

- Back stage

  Cloud servers sync newly created stories to the linked parent accounts; the app development team maintains server stability and data security; the system ensures all data transfers comply with healthcare privacy regulations.



FUTURE PLAN

- Phase1 : Clinical Validation & Loop Closure

  Deploy first-generation devices in 2-3 partner hospitals to clinically validate emotional benefits and refine the user experience. Success is defined by gathering solid efficacy data and closing the "create-display-connect" service loop with a functional parent app.

- Phase 2: Ecosystem Expansion

  Expand horizontally into new hospital settings (e.g., waiting areas, bedsides) and vertically by enriching content through artist collaborations and a more advanced AI engine, building a robust content library and use-case portfolio.

- Phase3: Platformization & Scale

  Evolve from a product into an open platform by open-sourcing core tools to enable broader creation. Forge partnerships with NGOs and CSR programs to establish a sustainable, replicable model for "creative healing," aiming to set a global standard. .

03

SHOPAL

2022–2023

This project addresses the physical, mental, and time constraints mothers and similar groups during offline shopping through the **"Shopal" system**. The design integrates mobile resting, storage, personalized guidance, and a hands-free shopping process into one solution. By offering **on-demand support**, it transforms offline shopping into a relaxed and enjoyable experience, positioning technology as a **helpful companion** in daily life.

INSPIRATION

"The inspiration for this project came from a simple observation: after my mother gave birth to my younger sister, she almost stopped going to the mall. What was once a relaxing activity for her had turned into a heavy burden—requiring careful coordination of time, energy, and the need to carry various items."

"This shift made me realize that this dilemma is not unique to new parents. Elderly people whose stamina is not what it used to be, and young adults who feel exhausted after work, actually face a similar conflict: they may want* to go out and shop in person, but their bodies feel too tired, and they cannot find large blocks of time. In the end, they often either give up on the idea altogether or turn to online shopping instead."

BACKGROUND

Data analysis

Data reveals that childbirth drastically reduces mothers' offline shopping time (from 3.5h to 1.2h weekly) and frequency (from 4.2 to 2.1 monthly), with over 70% of trips becoming task-driven. Key pain points include: 92% citing heavy loads as a barrier ; 78% needing efficiency due to scarce personal time (~1.5h daily); 65% experiencing interruptions from childcare; and 72% stressed by multitasking, undermining the shopping experience.

Similar to the mother demographic, both seniors and energy-deficient young adults maintain a strong desire for offline shopping—seniors due to their need to verify product quality a, and young adults for the unique tactile experience and instant gratification. However, their actual offline shopping frequency fails to reflect this high intent due to core barriers shared with mothers: limited physical energy, a tendency toward fatigue, and a desire for efficient, low-effort experiences.

Problem statement

"New mothers, seniors, and fatigue-prone young consumers desire offline shopping, yet fragmented time, limited stamina, and carrying burdens prevent enjoyment. Current mall environments lack systemic support to reduce these barriers, suppressing their offline shopping demand."

MAPS AND NAVIGATION

PRO : Clear information
CON : Without guidance
Hard to remember

Digital map

PRO : Clear information
CON : Signal insensitivity
Must be carried

Portable map

PRO : Clear
CON : Affects aesthetics
Unable to popularize

Ground guidance

To optimize for tight schedules, shopping navigation helps. However, current mall guidance lacks personalization for specific groups like mothers.

PHYSICAL REST

PRO : Has a wide coverage range
CON : Disrupts shopping plan

Rest in shops

PRO : Fast and effortless
CON : inconvenient due to the large number of people

Mobility scooter

PRO : Has a wide coverage range
CON : Disrupts shopping plan

Public area

PRO : High level of rest
CON : Takes a long time

Rest capsule

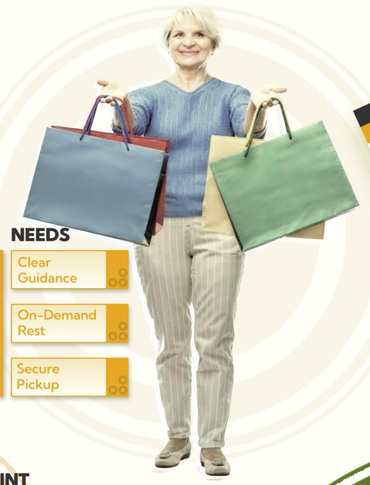
Available rest areas are often not nearby when needed, preventing on—demand rest. Likewise, storage lockers are usually only at entrances, making belongings inaccessible during the shopping trip.
Moreover, no existing facility integrates guidance, resting, and storage into a single solution.

CASE STUDY

PERSONA

PAIN POINT

Carrying the Load: Outings require a massive diaper bag (diapers, formula, cups, snacks), feeling like a weighted march.
Frequent Interruptions: Shopping is constantly disrupted by her child's needs, preventing relaxed browsing.
High-Decision Pressure: She must make quick purchasing decisions within limited time and with incomplete information, causing anxiety.



INFO

Profile: Retired primary school teacher who loves life and uses shopping to maintain social connection and discover new things.

Life Context: Has ample time but lacks the stamina for long walks or carrying heavy items. Not adept with smartphones, she deeply trusts the "see-it-and-touch-it" physical shopping experience but feels intimidated by complex mall layouts.

NEEDS

- Clear Guidance
- On-Demand Rest
- Secure Pickup

PAIN POINT

Difficulty Navigating: Easily gets lost in malls, struggling to find specific stores or restrooms.
Limited Stamina: Needs to sit and rest after about 30 minutes of walking; cannot continue browsing while carrying purchases.
The Digital Divide: Distrusts online product images but is also confused and resistant to self-checkout scans and complex digital coupons.

NEEDS

- Free Hands
- Hassle-Free Shopping
- Efficiency is Paramount

INFO

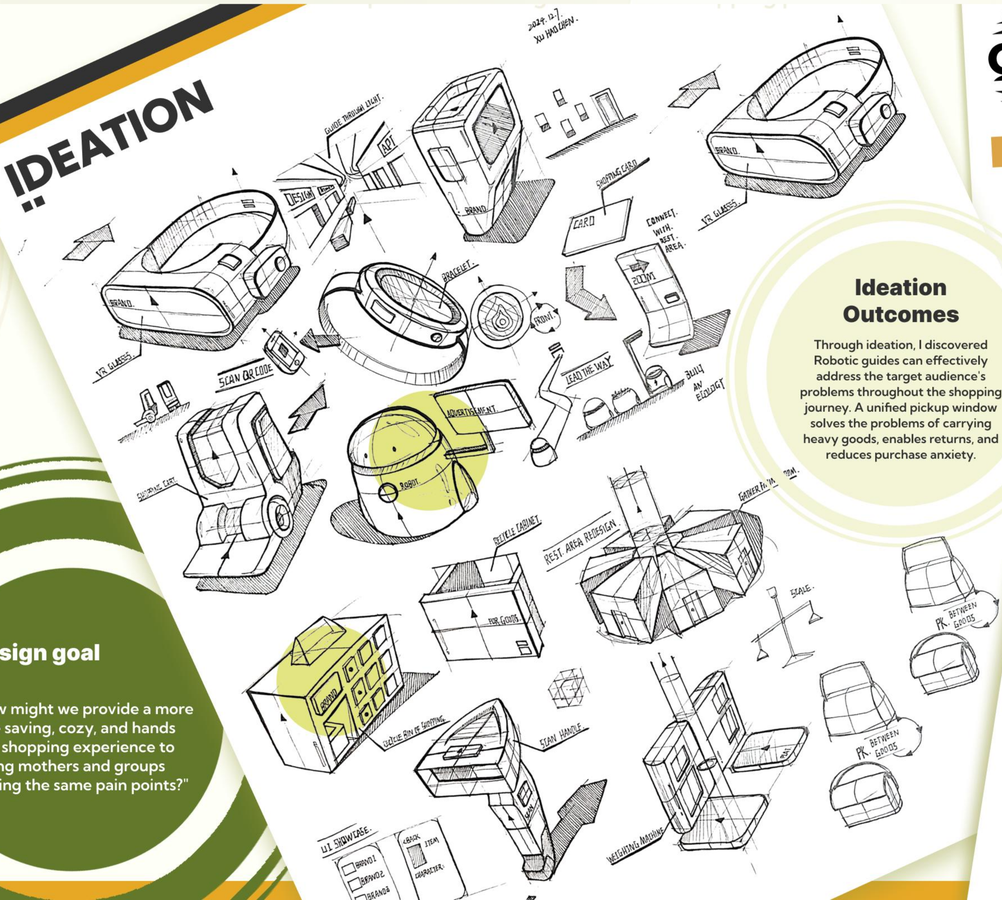
Profile: Project manager at an internet company, mother of a 2-year-old daughter.

Life Context: Her life is precisely divided into "work time" and "mom time." Personal leisure is highly fragmented, averaging less than 1.5 hours per day. Offline shopping is a meticulously planned "special operation" that must be efficient and allow for anytime interruptions.

Design goal

"How might we provide a more time saving, cozy, and hands free shopping experience to young mothers and groups sharing the same pain points?"

IDEATION



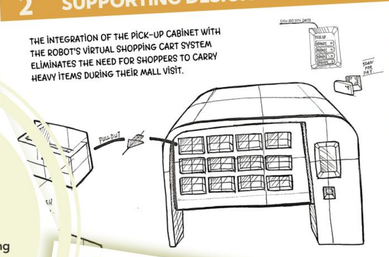
Ideation Outcomes

Through ideation, I discovered Robotic guides can effectively address the target audience's problems throughout the shopping journey. A unified pickup window solves the problems of carrying heavy goods, enables returns, and reduces purchase anxiety.

CONCEPT

2 SUPPORTING DESIGN - CABINET & CHARGING STATION

THE INTEGRATION OF THE PICK-UP CABINET WITH THE ROBOT'S VIRTUAL SHOPPING CART SYSTEM ELIMINATES THE NEED FOR SHOPPERS TO CARRY HEAVY ITEMS DURING THEIR MALL VISIT.

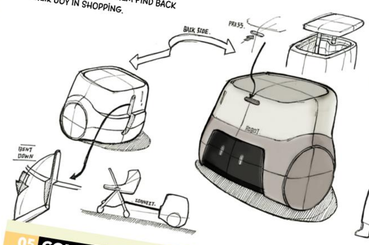


01 PICK-UP POINT
Users can retrieve the items scanned and added by the robot at the pick-up cabinet, and also be able to choose to return them back.

02 CHARGING
The distribution of robot charging and human resting places in the mall constitutes an ecology where humans and robots rest together.

1 SHOPPING MALL GUIDE ROBOT

AN COMPANION ROBOT THAT CAN SOLVE PROBLEMS IN SHOPPING, SUCH AS STORING BELONGINGS, SERVE AS A VIRTUAL SHOPPING CART, AND CARRY BABY STROLLER. LET THEM FIND BACK THEIR JOY IN SHOPPING.



01 VIRTUAL SHOPPING CART
Users can retrieve the items scanned and added by the robot at the pick - up cabinet, and also be able to choose to return them back.

02 STORAGE
Users can store their belongings under the seat while they enter the mall.

03 REST
User can seat on robots for rest during their shopping process anytime.

04 GUIDE
Users can interact with the screen or just talk to them, allowing the robot to lead the way.

05 CONNECTION
User can connect their baby stroller by bend down the structure at the back of the robot.

FINAL DESIGN

REST

User can sit on the robot for rest during their shopping process anywhere and anytime.

STROLLER TOWING

Users can connect their baby stroller by folding down the structure at the back of the robot.

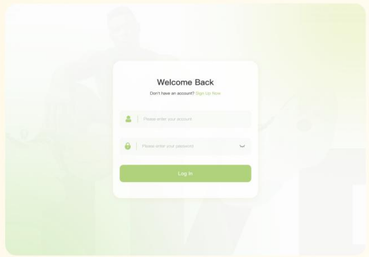
INTERACTION AND GUIDE

Users can interact via the touchscreen or by voice, and the robot will then guide the way to target store

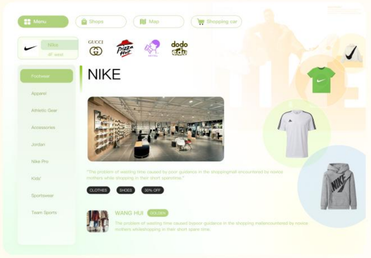
STORAGE

users can store their belongings under the seat.

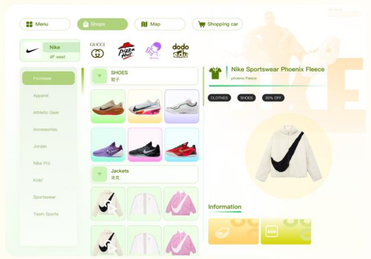
INTERFACE DESIGN



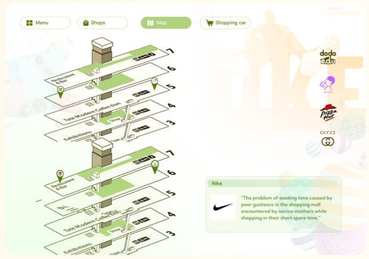
login interface



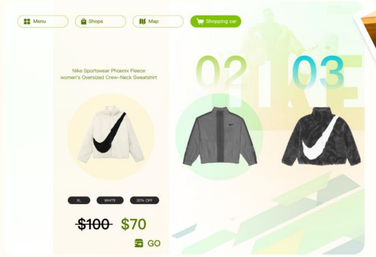
Shop interface



Product interface



Map navigation interface



Shopping cart interface

STORY BOARD

VISION ECHO

— ELECTRONIC ERHU

This project **re imagines the traditional Chinese erhu** through modern technology. The electronic erhu harmonizes classical artistry with contemporary innovation, making learning more intuitive via smart interaction, practice more flexible with portable design, and performance more expressive with real time visual feed back. It aims to **revitalize classical instruments with renewed accessibility** and flexibility

2023-2024

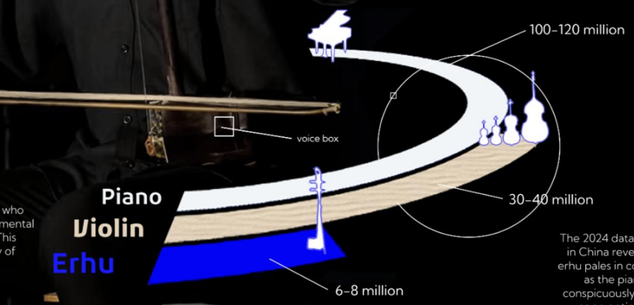
Background

ERHU

A traditional chinese instrument

Erhu is notoriously difficult to learn

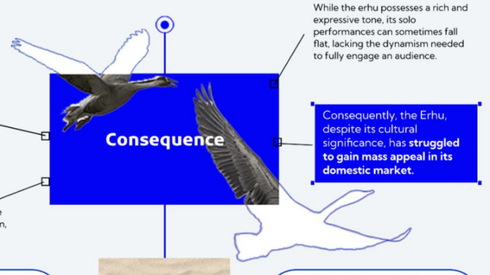
In the eyes of the vast majority of people who know music from social networks, the Erhu has a high level of proficiency and mastery, making it always high in the difficulty pyramid.



The total number of candidates who have sat for standardized instrumental music examinations in China.（This indirectly reflects the popularity of various musical instruments.）

The 2024 data on instrumental examinations in China reveals that the popularity of the erhu pales in comparison to instruments such as the piano and violin. Its uptake is conspicuously low, and it is seldom pursued as an option for self-guided learning.

Problem tree



Consequence

While the erhu possesses a rich and expressive tone, its solo performances can sometimes fall flat, lacking the dynamism needed to fully engage an audience.

Consequently, the Erhu, despite its cultural significance, has **struggled to gain mass appeal in its domestic market.**

The erhu has a notoriously steep learning curve. Beginners must invest significant time, face high training costs, and possess a degree of innate talent just to master its basic techniques.

Achieving proficiency requires developing muscle memory through long-term, disciplined practice.

Problem

How to reduce the difficulty of getting started with erhu and the time and talent cost during training, so that more people can have the ability to play erhu.

Erhu performance is often perceived as sonically monotonous. It lacks contemporary, dynamic, and sustainable appeal to engage modern youth.

Cause

The control of erhu music pitch can only be achieved through memory and long-term training

The erhu requires high accuracy in playing posture

The erhu has many high-level and difficult techniques, so musicians who have successfully mastered the basic erhu performance find it difficult to find their own playing style.

To master the playing technique of erhu proficiently, long-term muscle memory training is required.

The performance effect of erhu is monotonous

Opportunity

Simplify the structure of the Erhu while maintaining instrument logic, simplifying the difficulty of getting started

Provide a way to **make muscle memory training for erhu performance easy and fun**

Based on the more interesting and **cool appearance** and **performance effect** of Erhu

Visualize the playing techniques of Erhu through other means, simplify learning costs, and decrease the difficulty of recognizing one's own playing style.

Competitive products

01 Electronic Erhu

This electronic erhu uses electronic sound to adjust the tone and record music.

pro 1. Electronic sound generation solves the problems of noise and unstable sound.

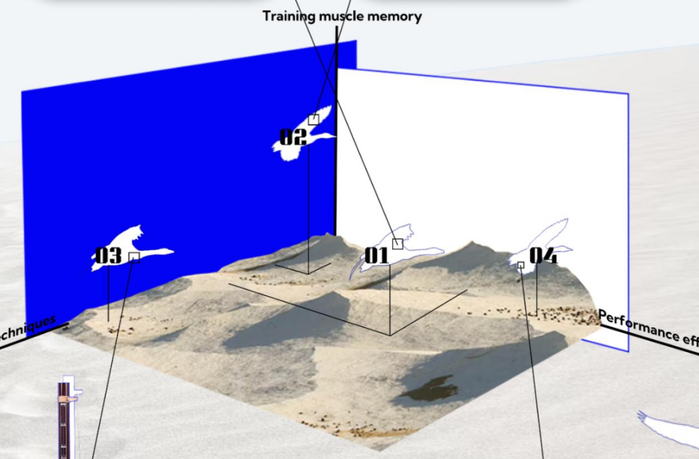
con 1. It is still necessary to find the sound by oneself.
2. Unable to perform techniques beyond the routine.
3. The appearance is simple and not cool enough.

02 Electric tadpoles

Electric tadpoles have a similar way of finding sounds to erhu, which can be used as toy instruments.

pro 1.You can practice finger positioning

Con 2.Mainly toys, it is difficult to achieve training effects, feedback is not clear enough, and it is inconvenient to use in public places.



03 Pitch Sticker

The pitch sticker is an auxiliary tool used to help novice erhu players find pitch when playing

pro 1.Effectively assisted in the process of finding sound.

con 2.Easy to develop dependence。

04 Visual Screen

Visualize the received music

pro 1. Transform the expression form of music

con 1. Separated from the instrument itself and not integrated into a whole
2. Lack of uniqueness and difficulty in connecting musical notes and rhythms themselves

PERSONA

MEG — A music lover

Pain Points:

1. Frustrating Start: Self-learning pitch and technique feels impossible without real-time guidance, leading to discouragement.
2. Monotonous Practice: Repetitive drills are isolating and hard to sustain without feedback or engagement.
3. Limited Expression: Her playing sounds thin and fails to convey the vivid atmospheres she imagines.

Core Needs:

1. Intuitive guidance for quick, confidence-building starts.
2. Engaging, adaptable practice with instant feedback.
3. Visual enhancement to unify sound and personal expression.

Info:
A university student and traditional music enthusiast drawn to the erhu's soulful sound. She seeks to learn but faces steep barriers.

Erhu Enthusiasts

VISION ECHO

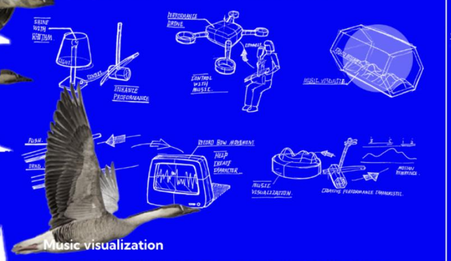
Insight

1. Unable to find a continuous and accurate demonstration.
2. Lack of time and space for muscle memory training.
3. Find practicing repetitively quite boring.
4. Lack of self awearness.
5. Feeling unfamiliar with the new instrument.

Brain storm

3 Find practicing repetitively quite boring.
4 Lack of self awearness.

Provide unique performance effects while making the performance cooler and giving each performance style a special visual effect.

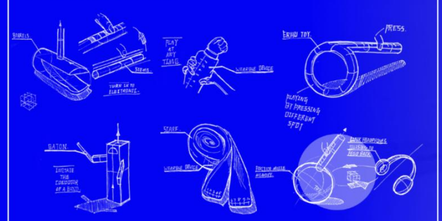


Music visualization

Music visualization technology converts audio signals into dynamic graphics (e.g., particle animations) in real time, making repetitive practice visually engaging and intuitive. By providing immediate feedback on pitch, rhythm, and emotional expression, it not only alleviates the monotony of traditional practice but also enhances self-awareness and practice efficiency through visual guidance.

2 Lack of time and space for muscle memory training.

Design additional daily use components to enable users to interact effectively and train erhu muscle memory

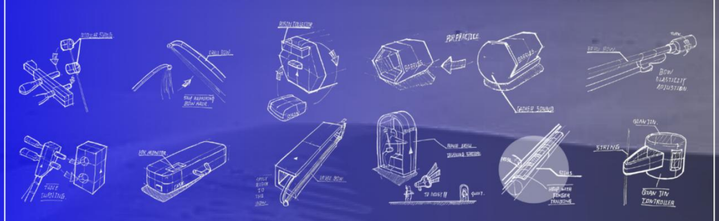


Muscle memory training module

A detachable muscle memory training module that attaches directly to the instrument, enabling users to seamlessly remove it for on-the-go practice. It supports finger-activated repetitive drills and provides real-time audio feedback through headphones, making skill development both portable and responsive.

1 Unable to find a continous and accurate demonstration.
5 Feeling unfamiliar with the new instrument.

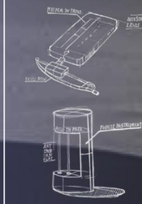
Simplify the difficulty of getting started with erhu manual operations. Simplify the difficulty of getting started with erhu manual operations. Simplify the difficulty of getting started with erhu manual operations.



Electronic fretboard for training assistance

A smart finger board system uses illuminated LED zones to provide step-by-step visual guidance, enabling beginners to quickly learn basic fingering and positioning on the erhu.

Other Innovative Design Approaches Related to the Erhu.



Concept

Digital Finger board Interface

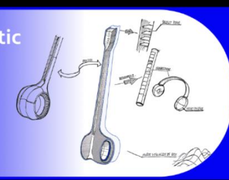
A touchscreen replaces traditional strings, offering visual guidance and reducing the initial learning curve for rapid familiarity.

Detachable Finger board

The removable digital Fret board functions as a standalone muscle-memory trainer, enabling portable, feedback-driven practice via touch interaction and audio cues.

Futuristic Aesthetic Design

Streamlined, sci-inspired form reinterprets the erhu as a visually striking instrument, enhancing its contemporary appeal.



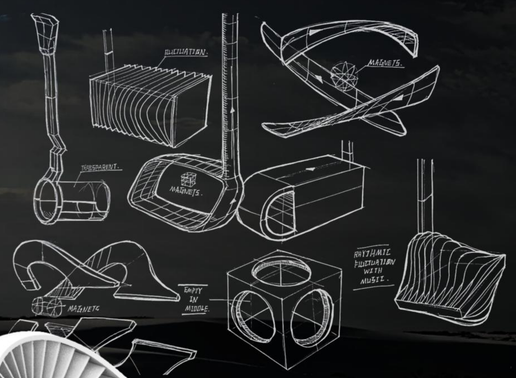
Responsive Visual Projection

Integrated TouchDesigner-powered projection generates dynamic particle visuals (e.g., migrating geese) that respond in real-time to the music's theme and rhythm.

Styling Evolution and Interaction Model Development

Erhu Body Design

The body design is a crucial component of the erhu's overall form. Beyond adopting a streamlined, futuristic shape, I incorporated a circular LED light ring, allowing the instrument to pulse and breathe in sync with the music during performance.



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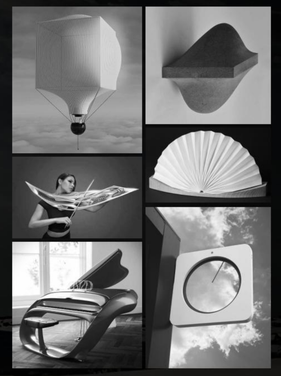
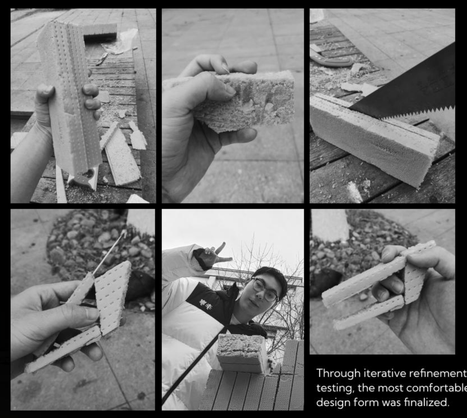
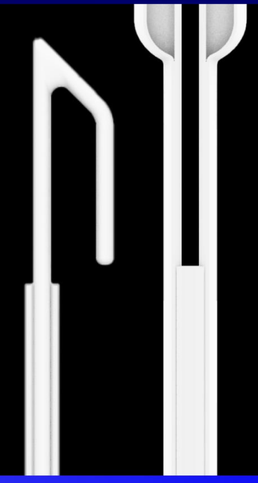


Bow Design

While maintaining the overall minimalist, streamlined, and futuristic style, the optimal bow size and form for ergonomic handling were finalized through foam prototype modeling.



Through iterative refinement and testing, the most comfortable design form was finalized.



Fingerboard Design

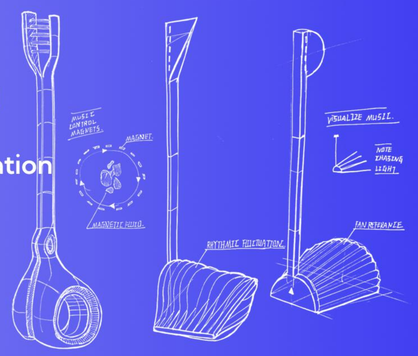
The fingerboard features a detachable structure, allowing it to function independently as a smart device for muscle memory training. The erhu neck adopts an elongated, hollowed-out design from top to bottom, which not only provides clearance for the bow to pass through but also maintains visual coherence when the fingerboard is removed.

VISION ECHO

Scroll Design

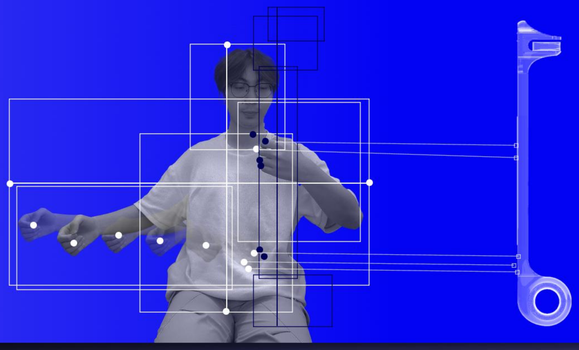
The scroll continues the minimalist, streamlined futuristic style, with enhanced dynamic lighting effects. Furthermore, by reinterpreting the traditional erhu scroll form, a dedicated integration slot was designed to embed the TouchDesigner projection module.

Overall Form Exploration



Overall Proportions

The overall dimensions are derived from the calculated dynamic range of human motion during performance, which in turn informs the erhu's proportional design to ensure optimal ergonomic comfort.

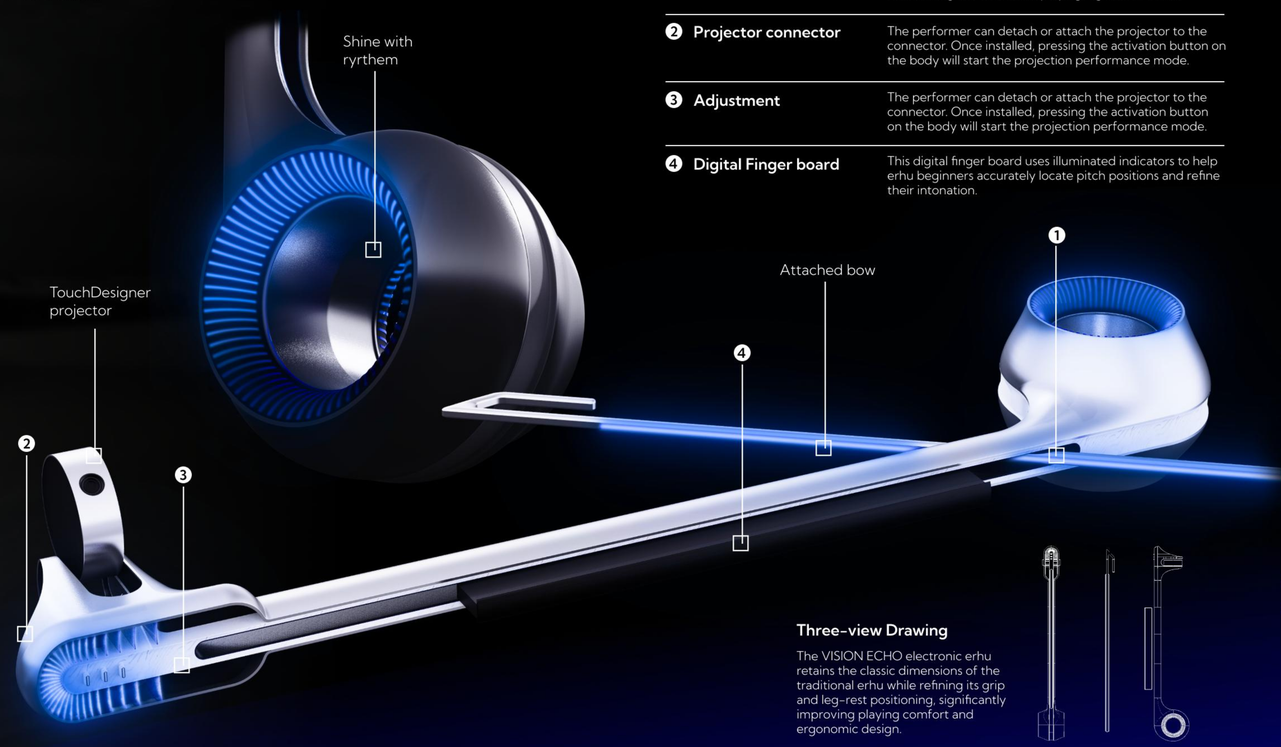


VISION ECHO

Final Design

This modern erhu features a touchscreen fingerboard for easy learning, a removable design for portable training, and a Futuristic aesthetic. Integrated projection creates real-time visuals that respond to playing, blending tradition with innovation.

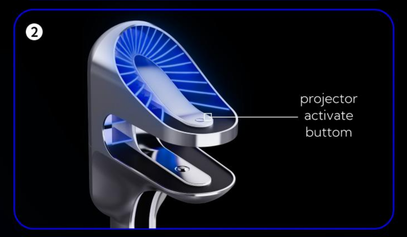
Details

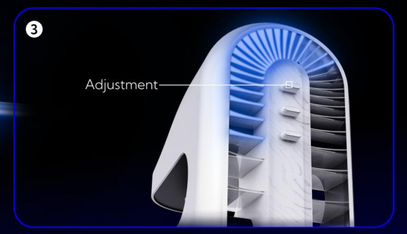


1	**Bow connection**	Electronic sounds are triggered by the contact between the bow and the recessed section of the instrument body, maintaining the traditional playing logic of the erhu.
2	**Projector connector**	The performer can detach or attach the projector to the connector. Once installed, pressing the activation button on the body will start the projection performance mode.
3	**Adjustment**	The performer can detach or attach the projector to the connector. Once installed, pressing the activation button on the body will start the projection performance mode.
4	**Digital Finger board**	This digital finger board uses illuminated indicators to help erhu beginners accurately locate pitch positions and refine their intonation.

Three-view Drawing

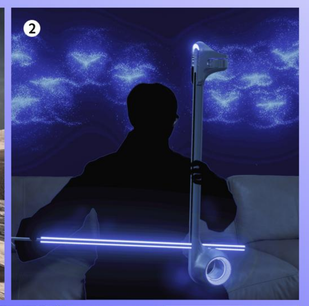
The VISION ECHO electronic erhu retains the classic dimensions of the traditional erhu while refining its grip and leg-rest positioning, significantly improving playing comfort and ergonomic design.

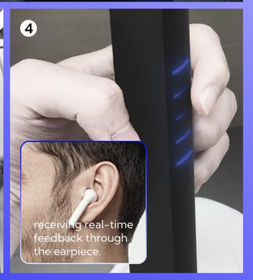




VISION ECHO

Renderings





1 2 VISUAL PROJECTION

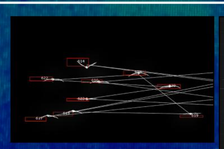
The performer activates the projector and begins playing a piece of desolate, mournful music. The system **recognizes the musical style and generates** a flock of particle-based geese that swirl and fly in sync with the melody.

3 4 MUSCLE MEMORY TRAINING

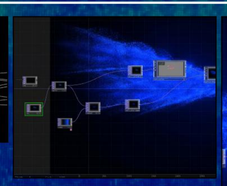
To practice muscle memory during spare moments, the performer **detaches the fingerboard**, takes it onto the subway, connects it to headphones, and starts practicing anywhere, **receiving real-time feedback** through the earpiece.

Physical Model Production

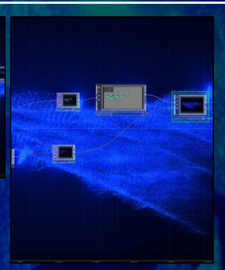
Model Creation and Immersive Performance



Animal Data Scanning



Touch Designer Creation (1)



Touch Designer Creation (2)

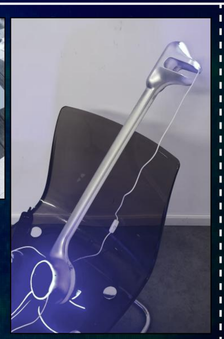
1 TOUCH-DESIGN

Music data is collected in real-time via sensors and fed into the TouchDesigner analysis system. The system deconstructs pitch, rhythm, and emotional characteristics (e.g., desolation, vastness) to identify the "style fingerprint" of the piece. For instance, a melancholic melody would be tagged as 【Frontier/Desolation】 style, triggering the corresponding "wild geese" visual asset library.

2 TOUCH-DESIGN

Based on the recognized style, TouchDesigner activates pre-programmed particle systems and motion rules. Taking "wild geese" as an example: the system generates particle flocks whose flight trajectories, density, and dispersion respond in real-time to the music's rhythm and dynamics. When the melody surges, the geese soar vigorously; during sustained phrases, they glide in gentle arcs, creating a deep, dynamic mapping between sound and vision.

3D printed model

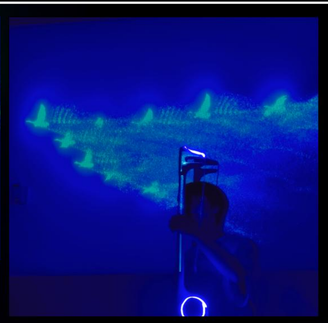


Model Painting and LED Strip Assembly

3 MODEL MAKING

The body is 3D-printed as a single unit, ensuring structural and ergonomic precision. A matte paint finish delivers a streamlined, sci-fi aesthetic. Flexible LED strips are embedded along key contour lines (e.g., the neck curve, resonance box outline). These strips are not merely decorative but visualize performance states: their brightness and color shift with touch intensity and projection content, transforming the instrument itself into a dynamic light medium.

Stage Effects (1)



Stage Effects (2)

4 PERFORMANCE

As the performer plays a melody depicting the frontier, particle geese generated by TouchDesigner "fly" out from the projection and interact with the instrument's LED lighting. The geese's flight path triggers pulsating light and color ripples along corresponding sections of the body, as if light emanates from the instrument to converse with the imagery. Thus, the physical model transforms from a passive object into an active, luminous participant in an immersive audiovisual narrative.