

02 / WEARABLE · INTERACTION · SAFETY

VIGIL

Fatigue Awareness for Skiers

VIGIL is a wearable fatigue-monitoring system designed for skiers. By sensing changes in muscular condition, it brings attention to fatigue that can be difficult to notice on the slopes. The design pairs a thigh-worn sensor with a simple ski-goggle interface, turning bodily signals into clear, timely cues to help skiers adjust their pace and decide when to rest.

SKIING EXPERIENCE · MUSCLE FATIGUE · WEARABLE FEEDBACK

Individual project

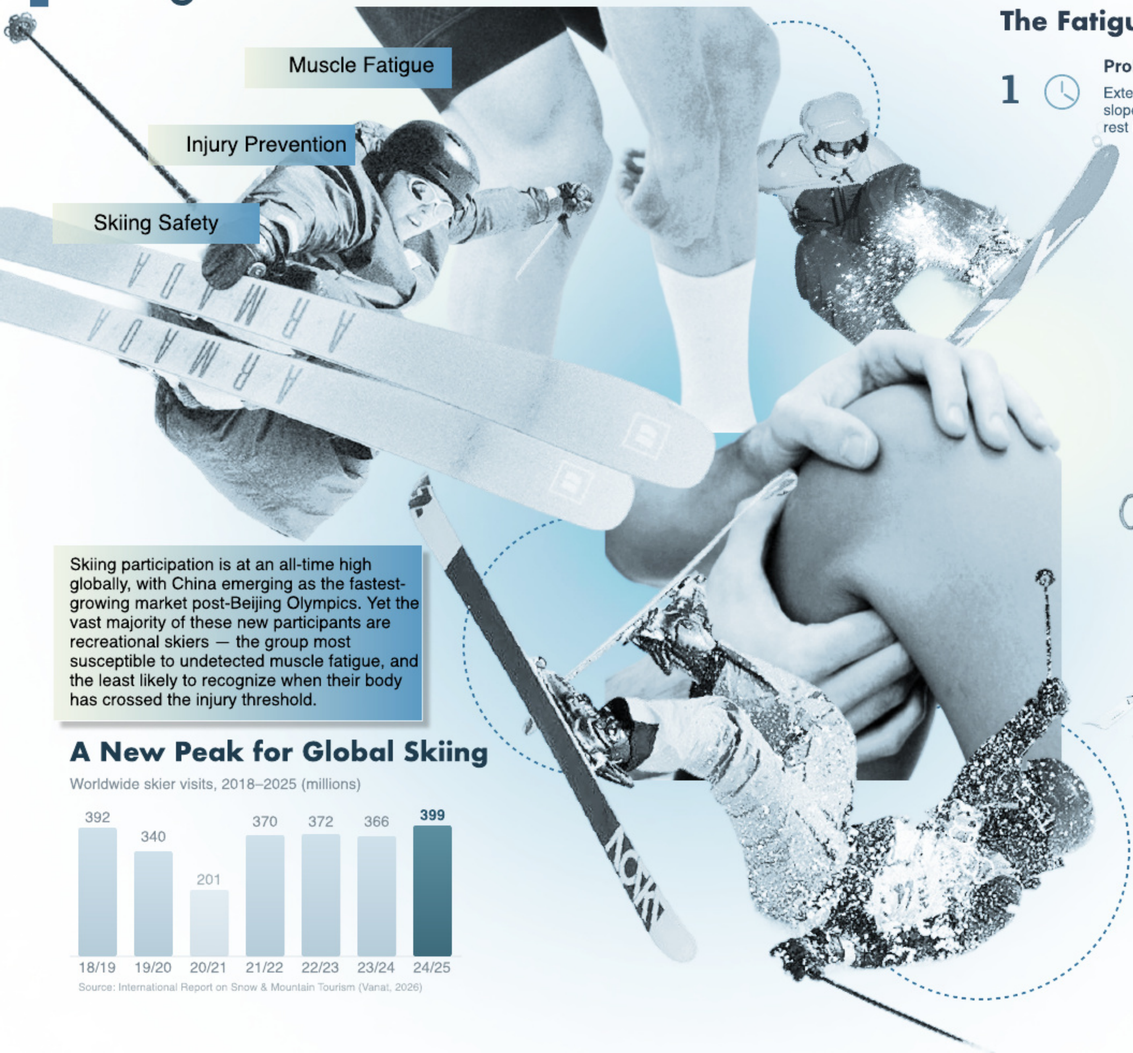
Creation period: May–July 2026

Background

Muscle Fatigue

Injury Prevention

Skiing Safety



Skiing participation is at an all-time high globally, with China emerging as the fastest-growing market post-Beijing Olympics. Yet the vast majority of these new participants are recreational skiers — the group most susceptible to undetected muscle fatigue, and the least likely to recognize when their body has crossed the injury threshold.

A New Peak for Global Skiing

Worldwide skier visits, 2018–2025 (millions)

Source: International Report on Snow & Mountain Tourism (Vanat, 2026)

The Fatigue–Injury Chain

1 Prolonged Skiing

Extended hours on the slopes without adequate rest intervals.

25% of injuries occur after 6+ hrs

2 Muscle Fatigue Accumulates

Concentric & eccentric strength of quadriceps and hamstrings declines measurably within a single day of skiing.

A 45-min lunch break shows no recovery effect (EMG)



3 Physical Response Declines

Reaction time slows, coordination deteriorates Joint stability decreases, especially at the knee

Knee injuries account for 30–40% of all ski injuries

4 Injury Risk Surges

Peak injury window: 2:00–4:00 PM.Intermediate skiers lose posture control under fatigue, triggering compensatory muscle patterns.

60% fatigue-linked

80% of skiing injuries are non-contact and theoretically preventable — yet skiers still have no way to sense their own fatigue in real time. This is the problem worth solving.

Research

Existing Tools

Existing tools either track macro health data, measure skiing performance, serve professional athletes only, or react after injury. None bridge the critical gap: detecting real-time muscle fatigue in recreational skiers before it leads to harm.



Smart Watches

Macro body data only , no muscle-level insight.



Ski Sensors

Tracks performance not physical fatigue.



Pro EMG

Lab-grade precision but not consumer-accessible.



Safety Gear

Reacts after impact no fatigue warning.

GAP — No product detects fatigue before injury occurs

Muscle analysis

Gluteus medius

Outer hip

Stabilizes the knee during edge transitions; fatigue causes inward collapse, straining the MCL.

Quadriceps

Front thigh

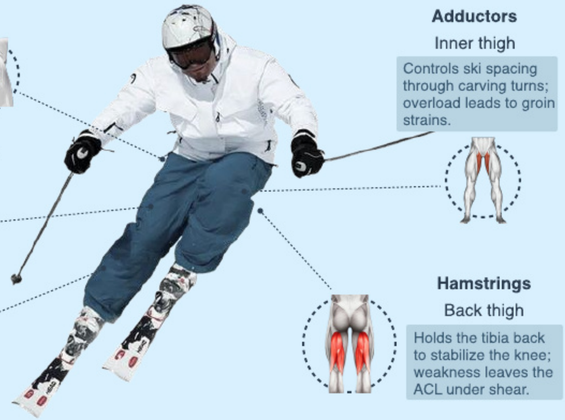
Most prone to injury from fatigue

Brakes leg extension in every turn; fatigue triggers knee buckling and ACL rupture.

Tibialis anterior

Front shin

Pushes the shin against the boot to control skis; sustained tension causes shin bang.



Adductors

Inner thigh

Controls ski spacing through carving turns; overload leads to groin strains.

Hamstrings

Back thigh

Holds the tibia back to stabilize the knee; weakness leaves the ACL under shear.

Among these five muscle groups, the quadriceps fatigues first and carries the greatest injury risk. The hamstrings and gluteus medius follow closely, together forming the primary monitoring zone for knee protection

User Study

Interview

I interviewed two skiers of different levels to understand how they sense （or fail to sense） physical fatigue while on the slopes.



Shu

Recreational beginner

Age : 24 · Female

Ski experience :1 season

Frequency: 30days / season

On the slopes I never feel tired . I'm too excited. But after every session my legs ache so much I can't sit or push off.

"I can't tell when I'm fatigued — until it's already too late."

NEEDS	PAIN POINTS	GOALS
Objective fatigue cues	Thrill masks fatigue	Ski within her limits
Prompt to rest in time	Aching legs afterward	Avoid overexertion
Beginner reassurance	No inner warning sign	Build confidence



Hao

Experienced enthusiast

Age: 34 · Male

Ski experience : 6 years

Frequency: 15–20 days / season

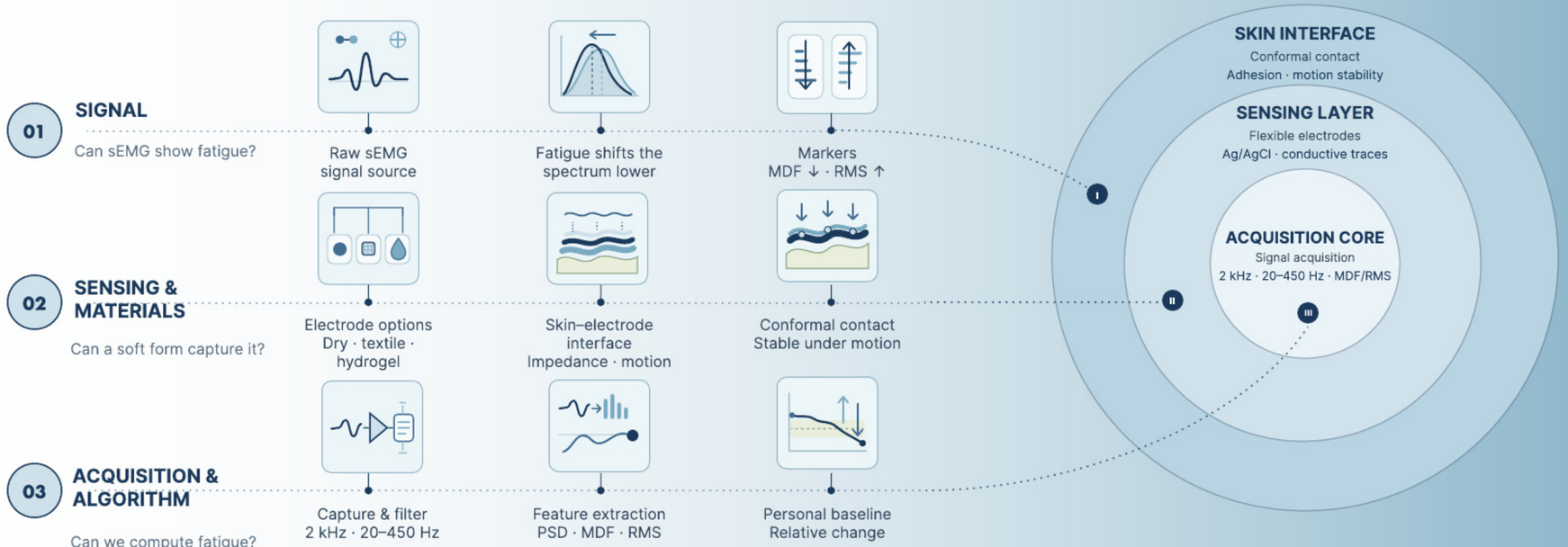
My worst falls always come on the last run — my legs are done, but I always want just one more.

"I trust how I feel — but my legs give out before I admit it."

NEEDS	PAIN POINTS	NEEDS
Time the last safe run	Chases "one more run"	Perform without injury
Load & recovery data	Pushes past fatigue	Know when to stop
Season-long tracking	Prior fatigue injury	Track progress

INSIGHT *Both skiers misjudge fatigue in the moment — makin the case for objective, real-time monitoring over gut feel.g*

TECHNICAL FEASIBILITY



CONCLUSION

Surface EMG provides a credible basis for fatigue sensing: sustained fatigue is typically associated with lower MDF and higher RMS. A 2 kHz acquisition chain with 20–450 Hz digital filtering is technically feasible. The key design challenge is maintaining stable, low-impedance skin contact during skiing. Together, these findings support a three-layer architecture—skin interface, sensing layer, and acquisition core—ready for prototype validation.

references

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Concept

The name VIGIL comes from “keeping watch,” reflecting the system’s role as a quiet guardian on the slopes. Combining a smart thigh band with an intelligent ski-goggle interface, VIGIL monitors muscle fatigue and injury risk in real time, delivering clear feedback for a safer and more confident skiing experience.

01 PART 01 — ON THE BODY

The Wearable

A smart thigh band · sense + alert

- A flexible sEMG interface sits over the vastus lateralis.
- Soft sleeve form — gel pads now, printed electrodes next
- Haptic buzz rises with fatigue

sEMG patch + haptic core



02 PART 02 — IN THE VIEW

The Goggle HUD

Feedback in sight, hands-free

- Fatigue ring fills in real time
- Three levels — L1 Stable · L2 Reduce · L3 Recover
- Rest prompt only when it matters



HUD at the edge of sight

SENSE → COMPUTE → ALERT → REST

worn on the body · read in the eyes

The sleeve senses what the skier can't feel; the goggle shows it in plain sight — **fatigue becomes visible** before injury does.

Wearable System

Work Flow

01 / MUSCLE INPUT	02 / ELECTRODES	03 / AMPLIFY	04 / 2 kHz SAMPLE	05 / FEATURES	06 / DUAL LOGIC	07 / WI-FI OUTPUT
Vastus lateralis contracts under load.	Medical pads or OYMotion + gel.	20–500 Hz analog EMG front end.	ESP32-C6 reads A0 continuously.	Filter · window · RMS / MDF / MNF.	Labeled learning + 30 s personal baseline.	Battery-powered stream to UI / AR.

Hardware Modules

SENSING HARDWARE



CONTACT · AMPLIFY · SAMPLE

OYMotion · Gravity EMG · ESP32-C6

SIGNAL PIPELINE

FILTER 20–450 Hz / notch

WINDOW 0.5 s / 50%

FEATURES RMS · MDF · MNF

2,000 samples / second

INTERPRETATION / TWO COMPLEMENTARY LAYERS

MULTIMODAL LEARNING CONCEPT

sEMG features + Borg labels + activity context explore patterns and help calibrate thresholds.

30 s PERSONAL BASELINE

Today's fresh RMS/MDF becomes the reference; live relative change creates L1 / L2 / L3.

POWER + WIRELESS OUTPUT

BATTERY POWER

WI-FI DATA STREAM

No USB tether during use. ESP32-C6 sends live sEMG to the web UI and future AR cue.

L1 | L2 | L3

Experimental Testing



01 / MATERIAL PREP

Prepared silicone, fabric, electrodes and electronic components for iterative prototyping.



02 / SILICONE MOLDING

Modeled the mold and cast a soft silicone layer to create stable skin contact.



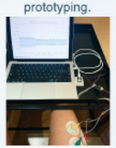
03 /POD CAD

Modeled the electronic pod around the sensor, controller and battery layout.



04 /POD FABRICATION

3D-printed and machined the enclosure to refine component fit and assembly.



05 / SIGNAL CAPTURE

Captured the first raw sEMG signal and displayed its live waveform.



06 / ELECTRODE COMPAR

Compared dry electrodes with conductive paste and disposable gel electrodes.



07 /INTEGRATION

Soldered the battery and integrated the controller and wireless transmission module.



08 / WIRELESS TEST

Verified live sEMG transmission and feedback through the companion UI during on-body testing.

SKETCH



Coding

From raw voltage to a personal warning: the pipeline captures, cleans and translates sEMG into an explainable fatigue level in real time



01 / CAPTURE + CLEAN

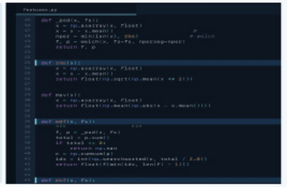
The sensor streams 2,000 samples per second. Filtering removes motion and mains noise before analysis.

RAW sEMG → CLEAN SIGNAL

02 / CALCULATE

Each 0.5-second window becomes RMS, MDF and MNF.Together they describe amplitude and frequency.

RMS ↑ / MDF ↓



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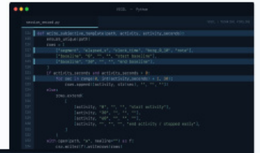
BORG 0–10 / REAL SESSION

30 s = 5 · 45 s = 8 · 65 s = 10

03 / LABEL + STORE

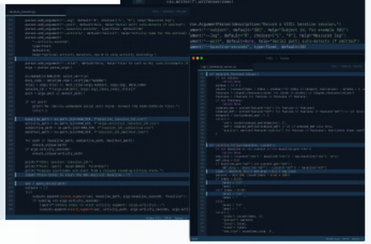
Feature rows are paired with fatigue state and source.



04 / PERSONALISE

A 30-second wall-sit sets today's personal reference. Live RMS/MDF change then becomes L1, L2 or L3.

30 s DAILY BASELINE



Multimodal Learning

multimodal learning reveals shared fatigue patterns, while a live personal baseline keeps real-time feedback adaptive and explainable

PHYSIOLOGY	SELF-REPORT	CONTEXT
RMS · MDF · MNF	Borg 0–10	activity · duration

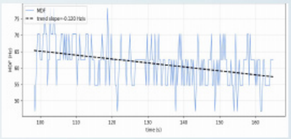
MULTIMODAL LEARNING CONCEPT

Explore shared fatigue patterns and calibrate future thresholds.

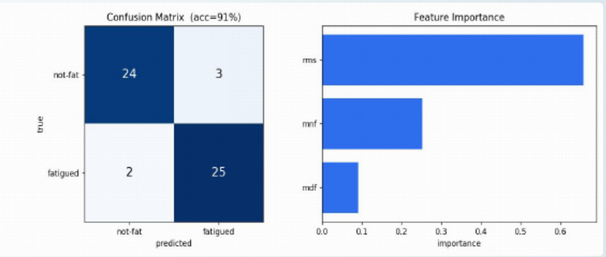
EVIDENCE FROM THE FIRST LABELED SESSION



RMS rises with effort.



MDF falls with fatigue.



91% Proof of feature separability — not population accuracy.

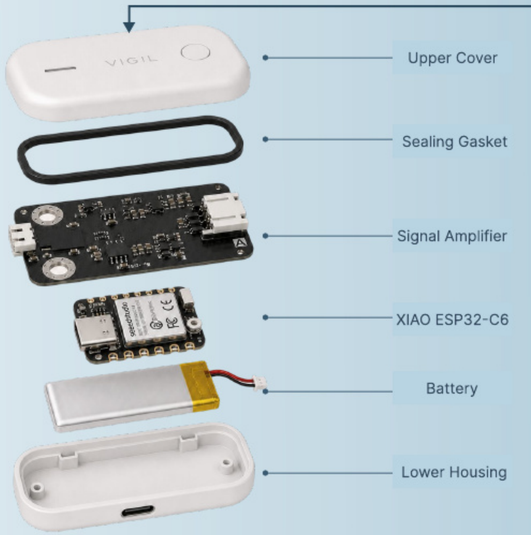
LEARNING LAYER	discovers patterns + calibrates thresholds
LIVE BASELINE	adapts the system to today's individual

COMBINED OUTPUT

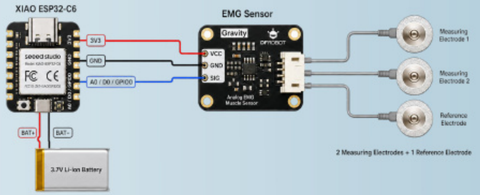
30 s daily reference + learned feature knowledge = personalised fatigue intelligence

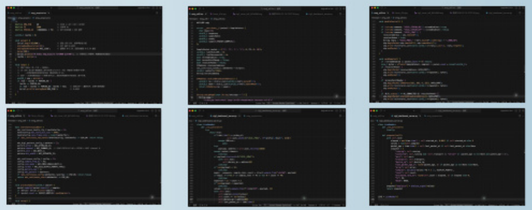
BOTH LAYERS REMAIN PART OF THE SYSTEM

Explosion



Physical Computing







GOGGLE INTERFACE



SCREEN 01 / STATUS

OVERVIEW

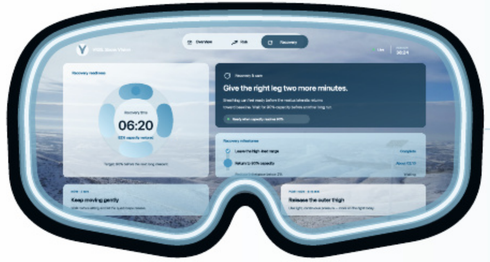
Shows muscle capacity, fatigue-related risk and the recommended action. Supporting cards add leg balance and the live sEMG signal.

SCREEN 02 / TREND

RISK TREND

Maps RMS and MDF against the 30 s baseline. The curve shows how fatigue-related risk builds across a run.





SCREEN 03 / RECOVERY

RECOVERY

Turns fatigue into a timed recovery plan. Rest guidance and readiness criteria support a safer return to skiing.

Final Outcome

EXPERIENCE FLOW

01 WEAR THE BAND
Position it over the vastus lateralis.

02 CALIBRATE FOR TODAY
A 30 s wall-sit sets the personal baseline.

03 SKI + SENSE
Live sEMG is captured at 2 kHz.

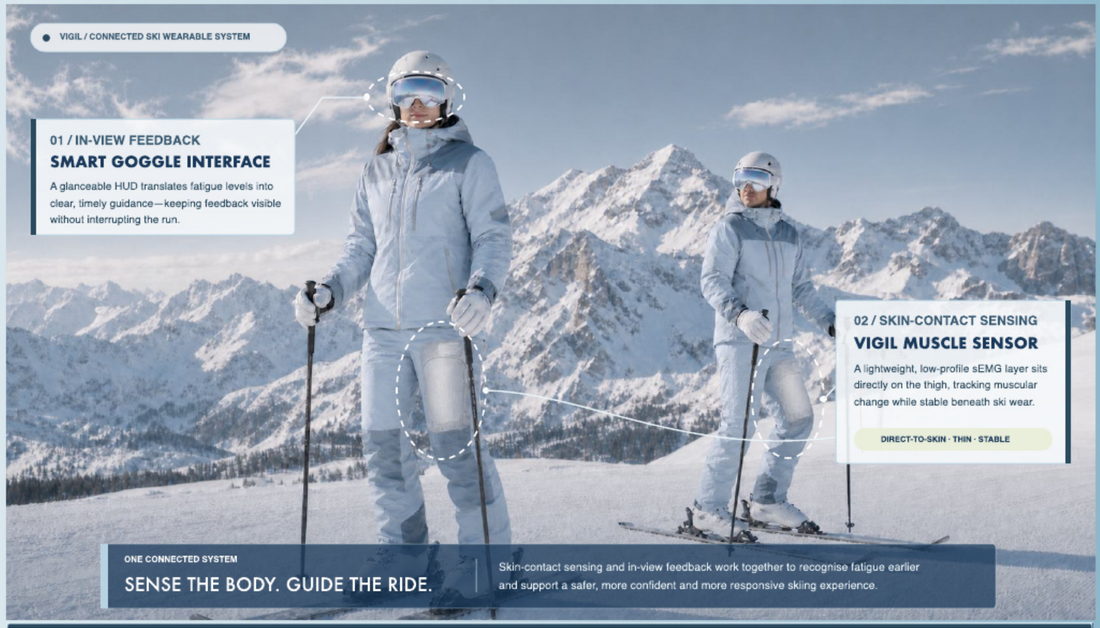
04 COMPARE WITH BASELINE
RMS ↑ and MDF ↓ reveal relative fatigue.

- L1 / STABLE — CONTI NUE
- L2 / REDUCE — SLOW DOWN
- L3 / RECOVER — REST NOW

05 GUIDE IN VIEW
Goggle HUD + haptic cue delivers the action.

06 RETURN SAFELY
Resume when capacity recovers.

NEXT RUN



Initial Evaluation

Initial wear trials suggest that VIGIL can maintain stable skin contact without restricting movement. Preliminary signal data and participant feedback support the value of timely, easy-to-understand fatigue cues. Further on-slope testing is required to validate long-term comfort, signal stability and threshold accuracy.

STABLE CONTACT · CLEAR CUES · FURTHER VALIDATION

Future Plan

VIGIL currently delivers feedback through a concise visual interface integrated into smart ski goggles. Future iterations will explore haptic alerts and coordinated feedback across additional wearable touchpoints. Together, they can evolve VIGIL into a connected ski system that senses fatigue, helps prevent injury and supports a more personalised, confident and enjoyable skiing experience.

SENSE · PROTECT · ENHANCE THE EXPERIENCE



01 / INSTALLATION · INTERACTION · WELLBEING

CloudSense

Installation Art
Interaction Design

In a world that moves too fast to feel, CloudSense invites you to pause. A gentle touch of its cloud-shaped form reads heart rate, skin conductance and fingertip temperature, translating changes in the body into visual feedback. Paired with a companion interface, it offers a quiet moment to notice how you feel and reconnect with yourself.

TOUCH · PHYSIOLOGICAL SENSING · SELF-AWARENESS

Individual project

Creation period: November 2025 – March 2026

INSPIRATION

Modern people lack the understanding of emotions in the context of fast-paced and information overload, and the term emotional value is frequently discussed. Therefore, accurate detection of emotions should be the starting point for understanding and intervention - transforming vague subjective experiences into quantifiable signals, providing the possibility of timely awareness and effective self-adjustment.



Question

Can emotions be quantified and regulated in some way?

BACKGROUND

The Causes of Emotions

Emotions are a dynamic feedback system: they influence behavior, which in turn affects new environments and stimuli.

1.External Stimuli

Perceptual input to the environment, such as sensory stimuli and situational events.

2.Cognitive Assessment

Meaning interpretation, expectation bias, value judgment



3.Physiological Responses

The body's immediate response to the results of the assessment.

4.Emotional Experience

Subjective experience integrated by the limbic system of the brain.

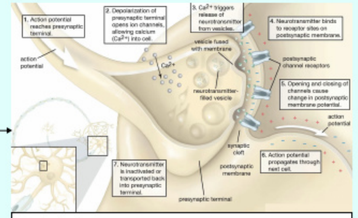
5.Behavioral Expressions

Emotions are explicit and feedback is generated on the environment.

Micro Level

Emotion follows a micro-pathway from rapid instinct to slower cognition

Sensory Input		
Quick Response	*Amygdala* →	*Hypothalamus*
Rational Evaluation	*PFC* →	Suppression Feedback
Integrated Experience	*Insula* →	Emotional Feelings



Hormonal Response

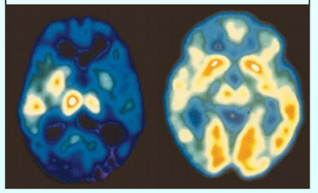
Neural signals trigger chemical releases that drive bodily emotional responses

RESEARCH

The Impact of Negative Emotions

BRAIN

Chronic stress can lead to poor concentration, low mood, personality changes and may even damage brain cells.

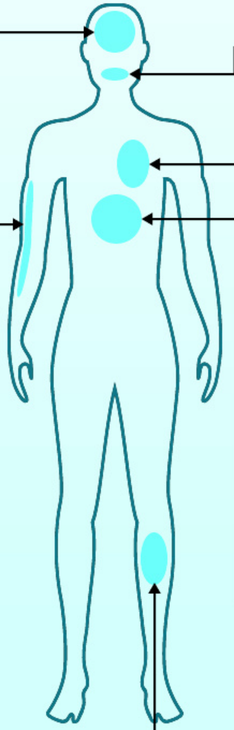


SKIN&HAIR

Eczema, acne and psoriasis can be triggered by negative emotions and periods of chronic stress. High stress levels can cause hair loss and even baldness.



Electrodermal Activity

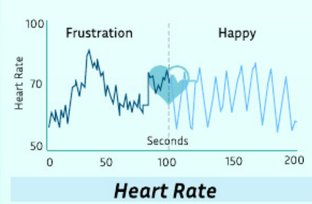


MOUTH

Mouth ulcers, dryness and even speech impediments can be affected by negative emotions and chronic stress.

HEART

Excessive adrenaline and cortisol production from negative emotions and stress can lead to hypertension, cardiovascular disease putting a strain on your heart.



Heart Rate

LUNGS

Chronic stress and negative emotions can trigger asthmatic symptoms like wheezing and bronchodliation.

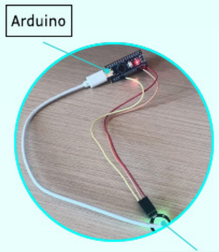
MUSCLES

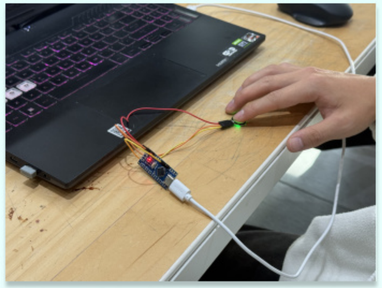
Negative emotions are stored as tension in muscles and can lead to muscle spasms, chronic pain, fatigue, even tics and tremors.

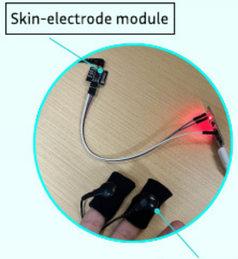
Long-term negative emotions keep the body in chronic stress, driving excess adrenaline and cortisol that harm multiple systems — impairing cognition, overloading the heart, weakening digestion, causing muscle pain and fatigue, and triggering skin, respiratory, oral, and reproductive problems. In short, unresolved stress and anxiety gradually shift from psychological states to real physiological damage through neuroendocrine pathways.

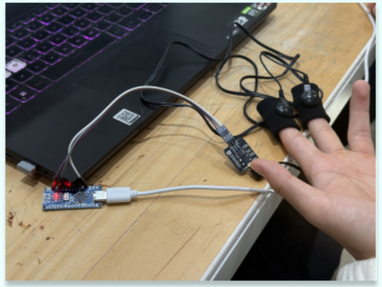
EXPERIMENT

Tech











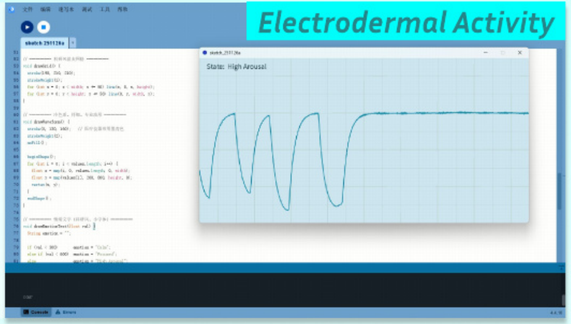


Module Experiment

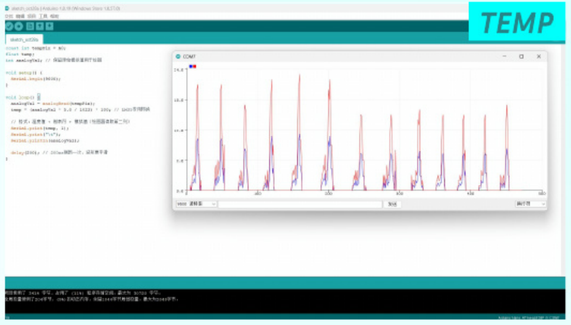
Heart Rate



Electrodermal Activity



TEMP



User Testing



Zhou Yue

23 · UI Designer · Shanghai

Problems

- Constant stimulation dulls emotional self-awareness
- Emotions only surface after they've impacted decisions

Motivations

- A calm, ritualistic moment to reconnect with herself

Quote：

Work's relentless, then I get home and scroll on autopilot. I've gone numb to how I feel. I only notice when I've already snapped or crashed. I just want something that lets me feel what's happening before it spills over

Testing 7 Days

Invited user to use CloudSense for one week while simultaneously recording subjective emotional experiences for cross-validation.

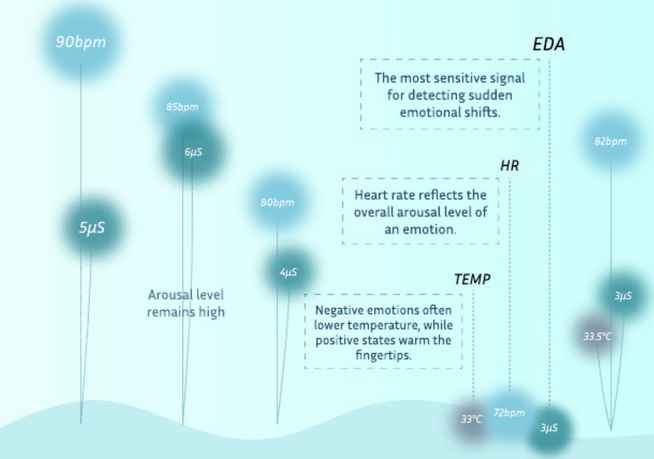
Installation Results

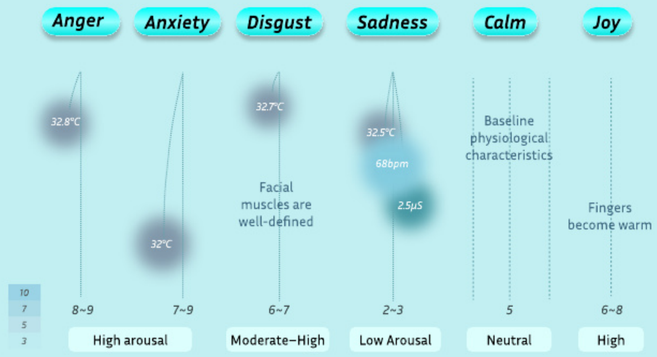




This report cross-referenced three physiological metrics collected daily with the subject's emotional self-reports, validating a strong correlation between physiological indicators and subjective emotional states.

Physiological Signatures of Emotion





Using baseline physiological indicators in a calm state, we can observe how these indicators change under various emotions and quantify the level of arousal, providing insight into emotional intensity. This data reveals how emotions affect the body and suggests that analyzing multimodal parameters can enhance our ability to identify an individual's emotional state.

CONCEPT

Emotion Perception

Multimodal Cross-validation

Subjective Emotions

Heart Rate

Skin Conductance

Fingertemp

Objective Data

(APP)

Emotional Feature Model

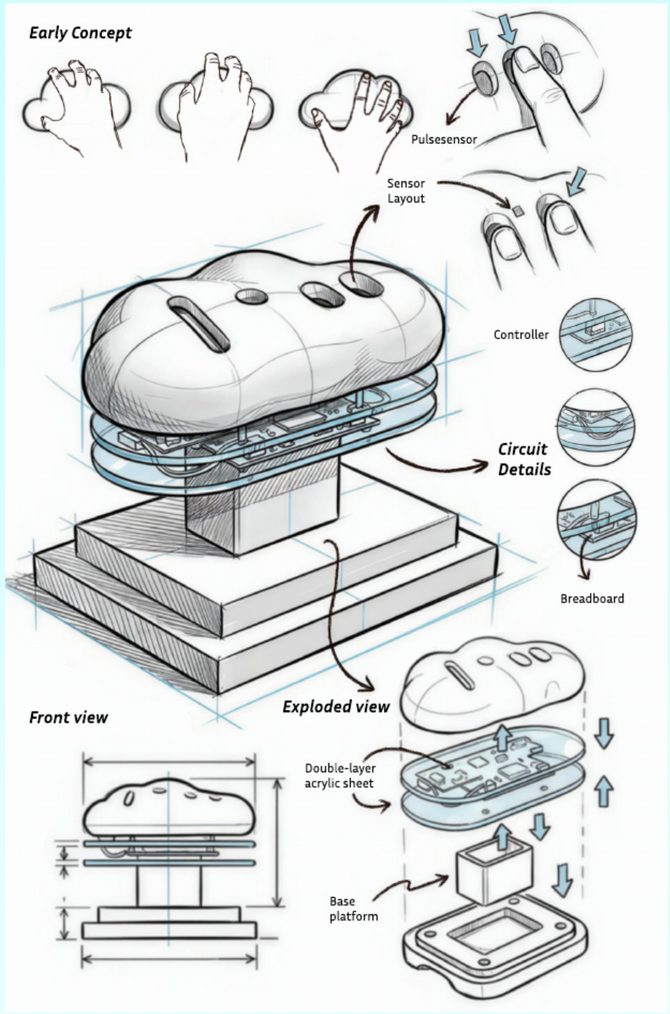
Self-awareness

Precision Emotional Intervention and Regulation (Food Compensation)

This project aims to establish a professional-grade emotional quantification system through multi-dimensional physiological data verification. Grounded in precise perception, it fills the gap in emotional self-awareness within fast-paced, information-overloaded lifestyles, achieving a complete closed-loop from data monitoring to proactive mind-body intervention.

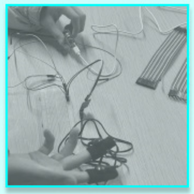
DESIGN

Sketch





Shape fabrication
Sculpt the basic shape and press out handprint.



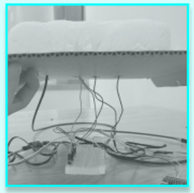
Circuit test
Connect the circuit and test the module's functionality.



Module combination
List all three components and begin assembly.



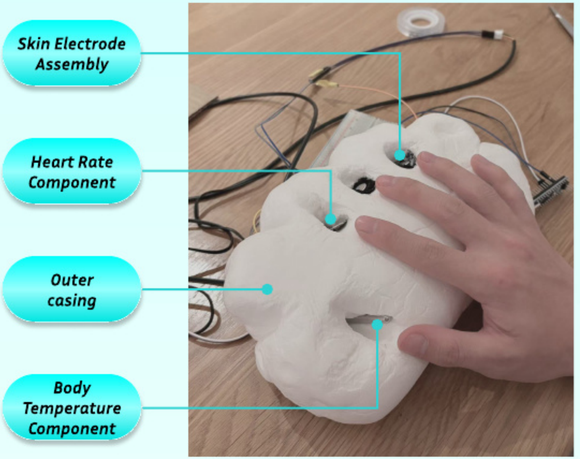
Circuit embedding
Embed each component and secure the housing



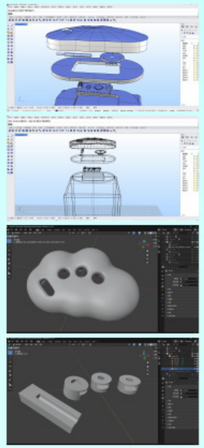
Structural erection
Connect the component's circuit downward.

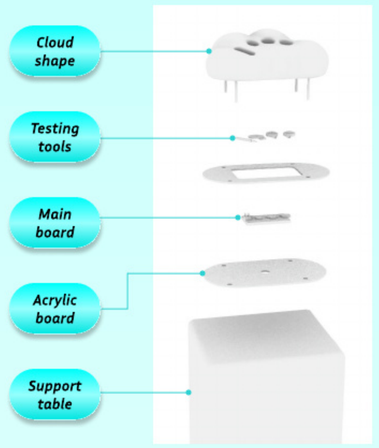


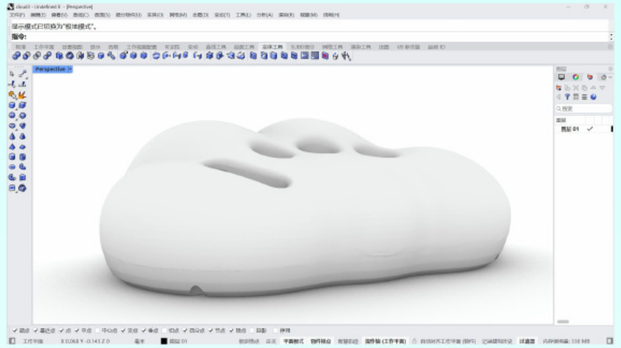
Preliminary testing
Complete model fabrication and conduct testing



Sketch





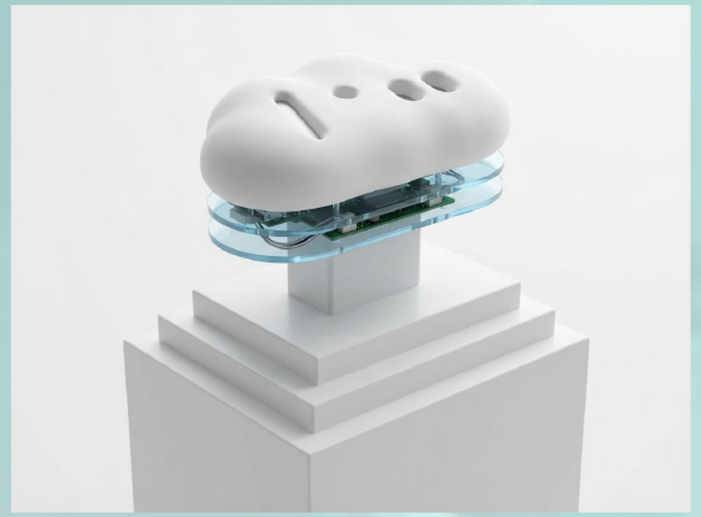


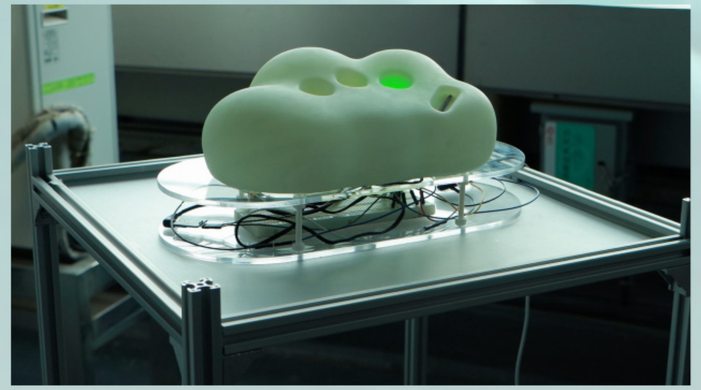




DESIGN

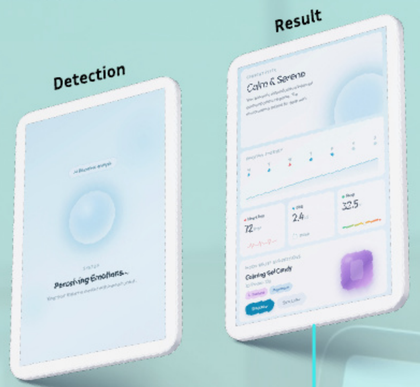
Rendering



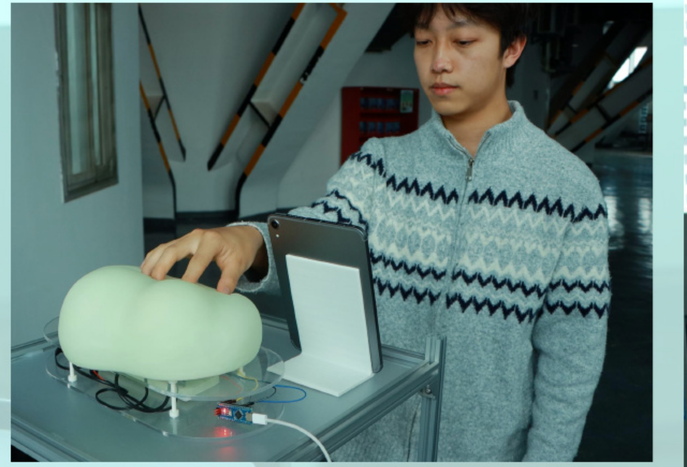


I first constructed product visualizations using online rendering tools, then after finalizing the form, translated the design into a physical model.

Interface







FINAL





03 / PRODUCT · SYSTEMS · ECOLOGY

COMMON GROUND

Modular Ecological Passage Zone

Around Qinghai Lake, pasture fences support herders' daily work while shaping the movement of Przewalski's gazelle. Common Ground explores adjustable passage modules within existing fences, connecting wildlife access with livestock management. Through human-confirmed operation and shared inspection and maintenance, the project reimagines a boundary that can open at the right place and time.

PASTURE BOUNDARIES · WILDLIFE PASSAGE · SHARED UPKEEP

Two-person collaborative project
My role: stakeholder analysis and system mechanisms; collaborative structure development and prototyping.

Creation period: July–August 2026

Observation & Context

A protected gazelle, a working pasture, and the people who maintain its boundaries.

01 A SPECIES WORTH PROTECTING

Przewalski's gazelle

Procapra przewalskii



Class I protected species · China

Endemic to China, with its remaining range concentrated around Qinghai Lake. Its habitat is also a landscape used for livestock grazing.

WHY THIS CONTEXT MATTERS

The starting point is a shared landscape, not an isolated animal. Protection has to consider the routes gazelles need and the everyday boundary that herders still depend on.

02 NOTICING THE CONFLICT

Pasture fences organise livestock and land use. The project began by reviewing what happens when gazelles meet these everyday boundaries.





01 / Contact with wire

Crossing attempts can bring the body into contact with the fence.



02 / Entrapment at the boundary

Posts and wire can become points of entanglement and injury.

READING THE BOUNDARY

VISIBLE IN THE MATERIAL

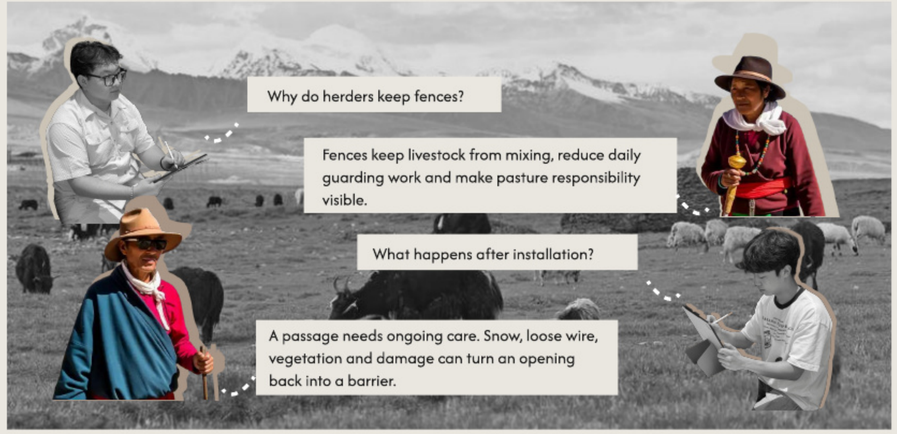
Wire contact during crossing
A boundary that still serves herding

QUESTION FOR DESIGN

Where can a lower-risk route be offered?
How can an opening remain controllable?

03 STAKEHOLDER INTERVIEWS

Listening to the people who keep the boundary working



INTERVIEW THEMES → DESIGN CRITERIA

01 / Keep the boundary useful
Retain its role in grazing, daily work and pasture responsibility.

02 / Make access conditional
Open at the right place and time, with livestock control in view.

03 / Design for continuing care
Make inspection, responsibility and repair part of the intervention.

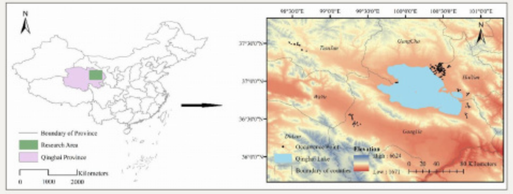
DESIGN QUESTION How might a working pasture boundary become selectively permeable, without transferring the burden to herders?

Field Analysis

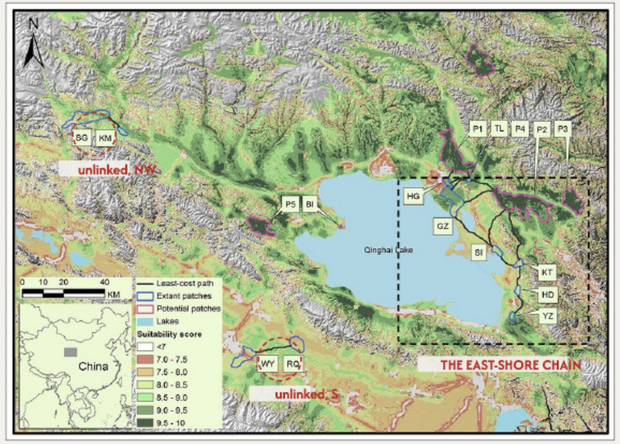
DESIGN IMPLICATIONS

The research suggests retrofitting gates at likely crossing points: low-level, barb-free openings with adequate clearance, operated after human confirmation to balance wildlife passage and grazing needs.

01 THE PLACE — where the population lives, and why movement is constrained

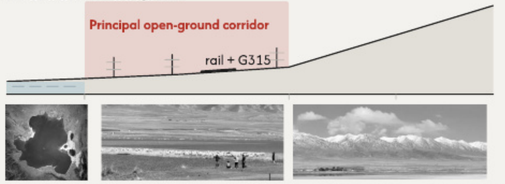


A · Study area and occurrence points.
The remaining wild range is concentrated around Qinghai Lake.



B · Habitat patches and modelled least-cost paths.

THE GEOGRAPHIC SQUEEZE



Contracted · fenced · rail · highway

The lake and steep ground funnel herds into one narrow lakeshore strip. Rail, roads and pasture fences occupy the same flat corridor.

01 2020–21: Haergai + Ganzihe held 76% of 4,078 animals.

02 2026 report: over 2,000 in the core (~80% of the basin).

03 Eight culverts (2007–09): no clear crossings recorded.

01 One east-shore strip
HG–GZ–SI–KT–HD–YZ follow the same narrow shore corridor.

02 Paths cross the fenced belt
Habitat links share the contracted and fenced lakeshore.

03 Outliers lack modelled links
Northern and southern outliers lie beyond modelled paths.

02 THE ANIMAL — movement, group behaviour and clear sightlines

Crossing as a group
Outside the rut, bachelor, female–young and mixed groups move and feed together. Mixed groups are largest.

~~Allow~~ a sequence of animals, not just one.

Group vigilance
Alert animals lift their heads and face the escape route. Body orientation helps the group follow.

~~Keep~~ the route legible from behind.

Open sightlines
Open, gently rolling habitats provide long views. Early detection and rapid escape matter more than cover.

~~No~~ blind corners, enclosures or dead ends.

Seasonal passage needs
The rut runs from late December to mid-January; lambing and rearing fall in July and August.

~~Passage~~ must accommodate adults and lambs.

WHAT THE ANIMAL READS

● Supported by evidence ○ Design caution / not established

SIGHT
- ● Open sightlines support early detection.
- ○ Avoid long streamers and snagging.

COLOUR
- ● Seasonal coat colours provide camouflage.
- ○ Use matte contrast; snow hides white.

SOUND
- ● No proven species-specific sound lure.
- ○ Avoid continuous or startling sounds.

SCENT
- ● No established species-specific scent lure.
- ○ No feed or salt: avoid attracting others.

TOUCH
- ● Wire contact can injure; rubbing unrecorded.
- ○ Avoid contact and horn-snag points.

FORM
- ● Native turf, visible exits and room to pass.
- ○ Narrow gaps may remain unused.

TWO PASSAGE MODES, DIFFERENT BODY NEEDS

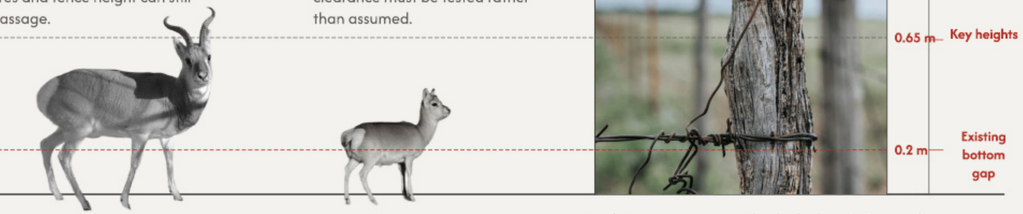
1.2% jump

Upper route: fence-wire clearance
Reported jumping ability does not make barbed-wire crossing safe. Thin wires and fence height can still block passage.

Lower route: ground-level clearance
A low bottom strand restricts passage for juveniles. Safe clearance must be tested rather than assumed.

81% walk along
Animals may follow the fence instead of crossing.

17.8% crawl under



adult · shoulder 50–60 cm

juvenile · 30–40 cm

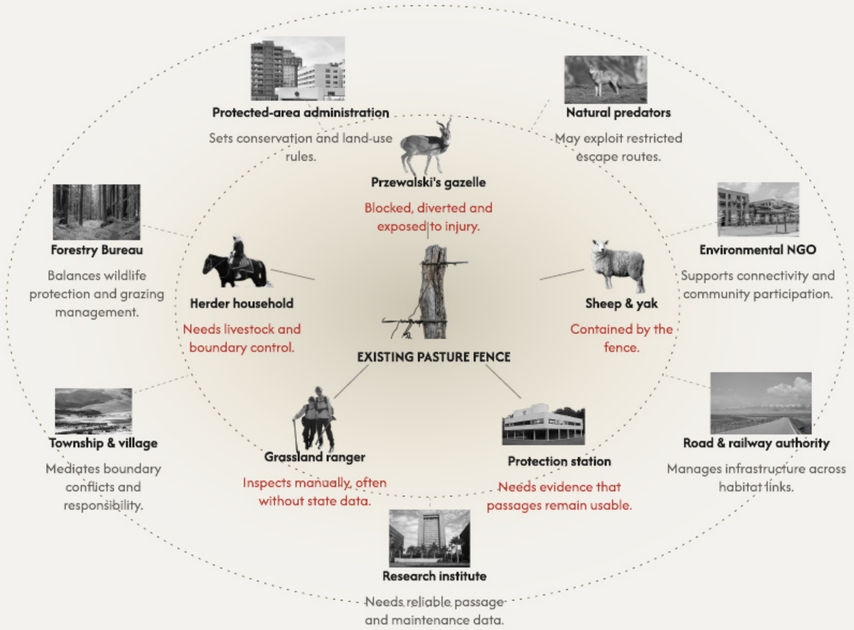
Low clearance restricts juveniles; barbed upper wires raise injury risk. Proposed dimensions need field testing.

0.65 m is a design hypothesis. Clearance and behaviour require field validation.

Observed sample: 168 animals

STAKEHOLDERS

Who depends on the fence, who is affected, and who maintains it?



Inner ring — directly affected or responsible for fence upkeep.

Outer ring — governs, studies or indirectly shapes the boundary.

DESIGN IMPLICATION

The fence links ecological costs, livestock control, land boundaries and maintenance. These responsibilities are shared; no single actor resolves the conflict alone.

The challenge: determine where, when and under whose responsibility the boundary becomes permeable.

PROBLEM & NEED

WHERE IT FAILS

— and what that costs on the ground

01

A barrier the animal cannot solve

A continuous wire line turns local movement into a search for a crossing that may not exist.

Reported daily movement: 7,223 vs 4,110 m.

02

The wire itself causes injury

Barbs and loose wires can catch crossing animals. Fence corners can restrict escape.

Entanglement and fence-corner mortality are recorded.

03

Removal gives up herder control

Fences mark contracted land and contain livestock. Removing them takes away a working tool without a replacement.

Removal acceptance: 20.78%; for protection: 34.21%; with compensation: 40.79% (n=141).

04

An opening cannot verify itself

Slack wire, snow or reclosure can stop a passage working. Without state records, failure may go unnoticed.

16 gaps (2008) and 8 culverts (2007–09): no clear crossing recorded.

WHAT IT HAS TO DO INSTEAD

— the brief, in four lines

01

Keep the boundary

Retain land-use legibility and livestock control.

02

Enable passage

Provide a low, barb-free route; test usable clearance.

03

Record state

Log clearance, lock state, openings, faults and crossings.

04

Reward upkeep

Pay for verified checks, operation and repair—not demolition.

DESIGN BRIEF

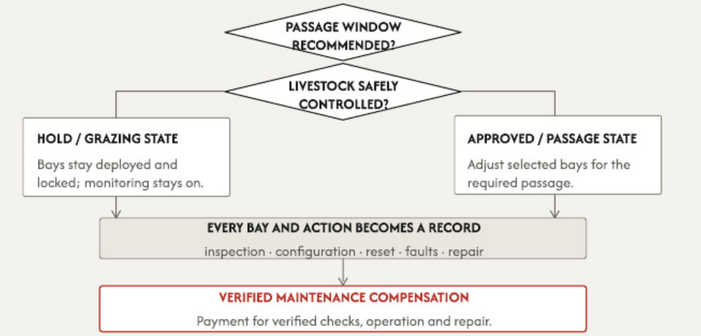
Replace a continuously closed, injurious and unverified boundary with a broad, adjustable passage zone—while retaining grazing control and clear responsibility.

CONCEPT

PROPOSED MODULAR ECOLOGICAL PASSAGE ZONE

Two or three linked modules form one passage zone.

01 MODULAR GATE	02 MONITORING	03 OPERATION
2–3 bays form one passage zone.	Camera coverage across the linked bays.	Recommends a passage window.
Upper and lower sections retract independently.	Tracks approach, direction and dwell.	A named operator confirms conditions.
Shared posts; independent bay settings.	Logs observed animals and crossing events.	Logs opening and closing.
Existing fences remain in place.	Position feedback and fault logging.	Operator resets after group-clear confirmation.



Records inform the next inspection and passage setup.

Linked gate units retain a fixed central cassette and retractable upper and lower sections. Monitoring suggests a passage window; a named herder or ranger confirms conditions, opens selected bays and resets them after the group has passed. Verified operation and repair records support the proposed upkeep-compensation process.

Design Process

Collaborative fabrication · an early trial, a new attempt, and the assembled prototype

01 / First attempt · joined-strip curtain


Paper sketch

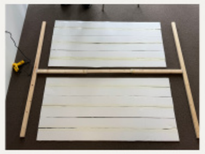

Material fold


Sheet preparation


Marking strips


Cutting strips


Strip layout


Joined-strip panels

Joined white strips formed an up-and-down curtain. The result was unsatisfactory, so we set this version aside.

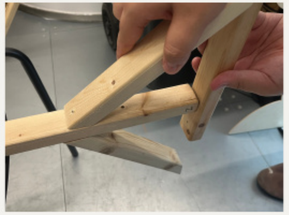
02 / A new attempt · building the support frame


Frame alignment


Base assembly

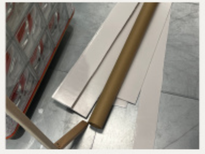

Joint fastening

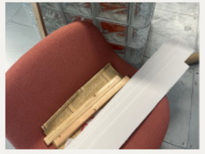

Fitting the feet


Braced support

03 / Roller, guide & connection studies


Roller study


Roller preparation


Channel profile


Trimming to size


Riveting the joint


Roller fitting


End connection

04 / Bringing the assembly together


Frame & roller


Assembling together


Securing the side


Assembly from above

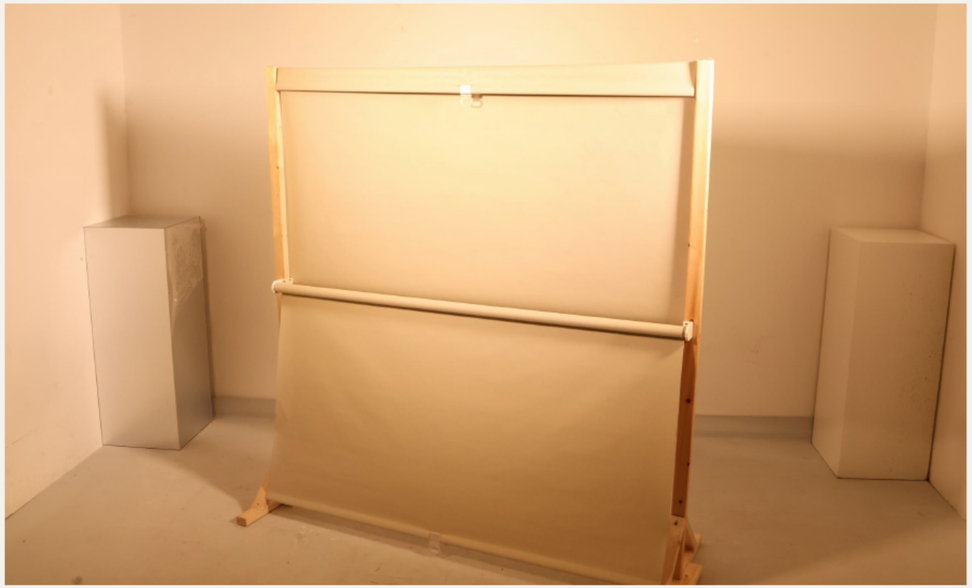

Upper panel fitted


Both panels fitted


Indoor prototype

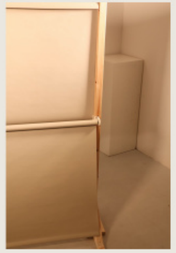
Mechanical Prototype

Physical construction · housing, support and roller connection



Assembled mechanical prototype

Near-full-scale prototype exploring panel retraction; the mesh-fence version is a later design proposal.


Housing & guide


Frame & base


Roller connection

Modular Ecological Passage Zone

Retractable modules within pasture fencing. A visible boundary, with human-confirmed openings for wildlife passage.



Grazing State / Fence Deployed



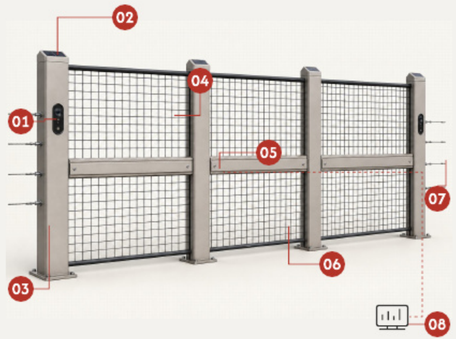
Upper and lower mesh sections form a continuous boundary.

Passage State / Fence Retracted



After human confirmation, both sections retract into the central cassette.

Components & Proposed Smart Integration



01 Camera monitoring
Captures approach, direction and dwell for human review.

02 Solar-assisted power
Proposed charging and storage; capacity to be sized.

03 Posts & guide channels
Link bays and guide the retractable sections.

04 Upper fence section
Deploys for grazing; retracts into the central cassette.

05 Central cassette & drive
Proposed roller drive stores mesh in a fixed cassette.

06 Lower fence section
Retracts upwards for barb-free, ground-level access.

07 Fence interface
Joins the modules to existing pasture fencing.

08 Control & event records
Commands, position feedback, fault and upkeep logs.

Operation Workflow

1. Monitor & notify
Camera events prompt the named operator to review.

2. Confirm & authorise
Check wildlife, livestock control and a clear route.

3. Open selected bays
Drive the sections; check end positions.

4. Observe passage
Keep the route clear. Do not move panels during crossing.

5. Restore & record
Confirm group-clear, restore the boundary and log the event.

Proposed safeguards: obstruction stop, end-position feedback and local manual override. Faults pause powered movement for operator inspection.

Mechanical prototype shown on the previous page; smart integration is proposed, not yet built or tested.

Proposed Upkeep & Compensation

01 / Record
Herder / ranger records operation, inspection and repairs.

02 / Verify
A designated reviewer checks the evidence and eligible work.

03 / Review
Claims are assessed against agreed pilot rules.

04 / Support
The project funder pays verified maintenance claims.

Reviewer, funding and payment rules must be agreed before a pilot. Compensation rewards verified upkeep—not wildlife crossing counts.

Concept visualisation · Animal passage, livestock containment, field durability and cost require validation.

Grazing state / boundary deployed



Passage state / controlled opening

