程恒锦

PORTFOLIO 2026

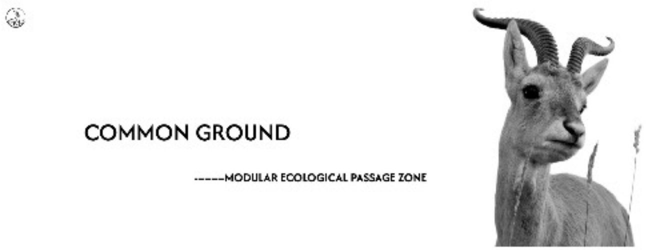
设计策略 · 智能产品 · 用户体验

Design Strategy · Intelligent Products · User Experience

南京农业大学 / 工业设计 / 2027届

01 **CloudSense**

02 **VIGIL**



03 **Common Ground**

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SELECTED PROJECTS

项目导读

01

CloudSense

情绪感知装置 · 生理传感 · 交互界面

02

VIGIL

滑雪疲劳预警 · sEMG · 可穿戴交互

03

Common Ground

生态通道 · 系统设计 · 多方协作

三个核心项目｜封面、项目名称与关键词均可在 PowerPoint 中直接修改

CloudSense

情绪自我觉察 · 多模态生理传感 · 实体交互

CloudSense
是一套面向快节奏生活的情绪自我觉察装置。用户触摸云朵形设备后，系统采集心率、皮电与指温，并在配套界面中呈现生理变化与主观情绪记录。项目结合传感模块实验、实体原型与交互界面，探索如何将难以察觉的情绪状态转化为清晰、温和且可行动的反馈
。

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.

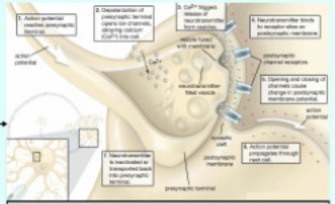
Micro Level

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

Sensory Input → Quick Response → Amygdala → Hypothalamus → Hormonal Response

Rational Evaluation → PFC → Suppression Feedback

Integrated Experience → Insula → Emotional Feelings



Hormonal Response

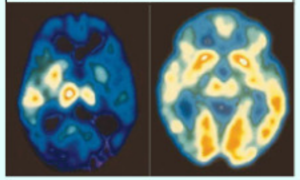
Neural signals trigger chemical releases that drive bodily emotional responses

RESEARCH

The Impact of Negative Emotions

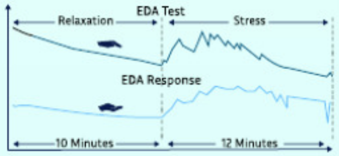
BRAIN

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.



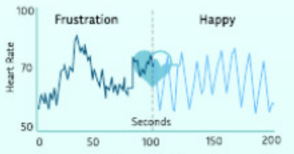
Electrodermal Activity

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.

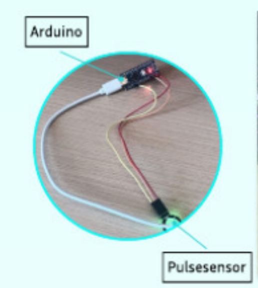
MUSCLES

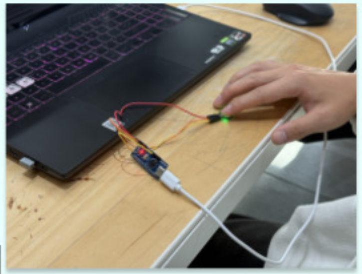
Negative emotions are stored as tension in muscles and can lead to muscle spasms, chronic pain, fatigue, even tics and tremors.

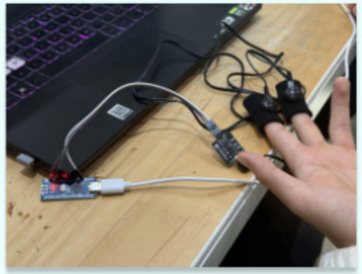
Long-term negative emotions keep the body in chronic stress, driving excess adrenaline and cortisol that harm multiple systems — impairing cognition, overloading the heart, weakening digestion, causing muscle pain and fatigue, and triggering skin, respiratory, oral, and reproductive problems. In short,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

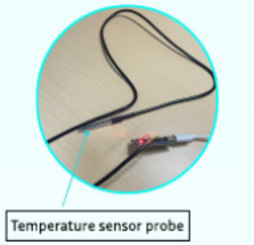
EXPERIMENT

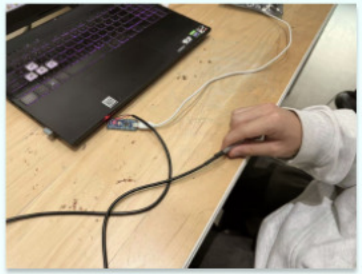
Tech



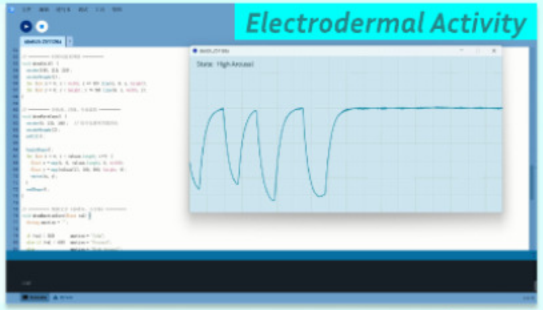


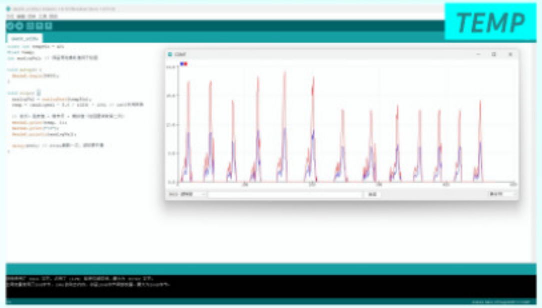






Module Experiment





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

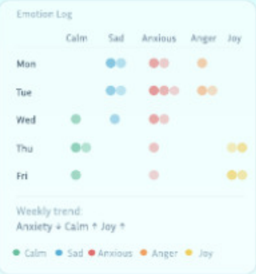
Quote :

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

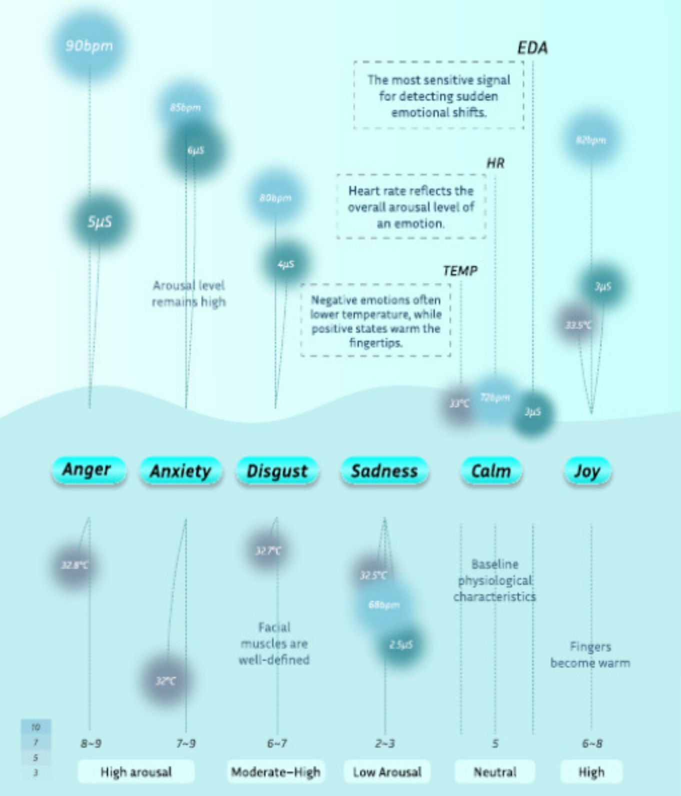
Invited user to use CloudSense for one week while simultaneously recording subjective emotional experiences for cross-validation.

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 → Heart Rate, Skin Conductance, Fingertemp → Emotional Feature Model

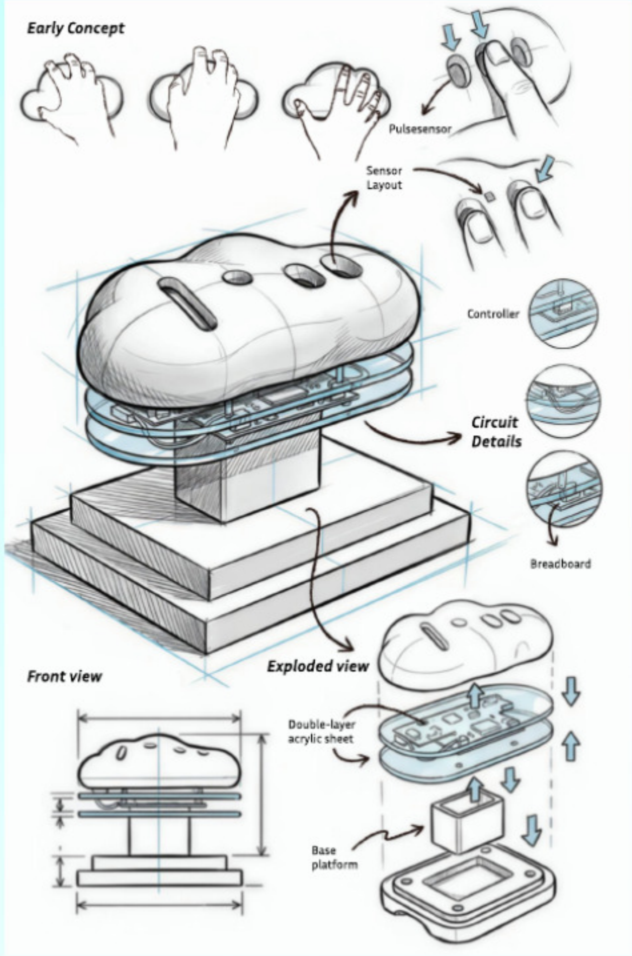
Subjective Emotions → Objective Data (APP) → Self-awareness

→ 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

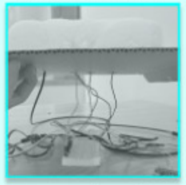


Shape fabrication
Sculpt the basic shape and press out handprint.

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

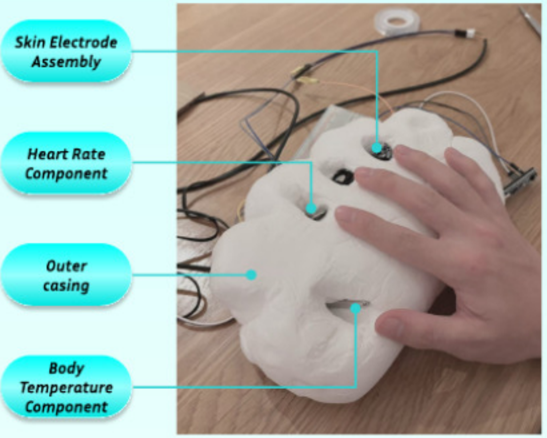
Module combination
List all three components and begin assembly.

Circuit embedding
Embed each component and secure the housing

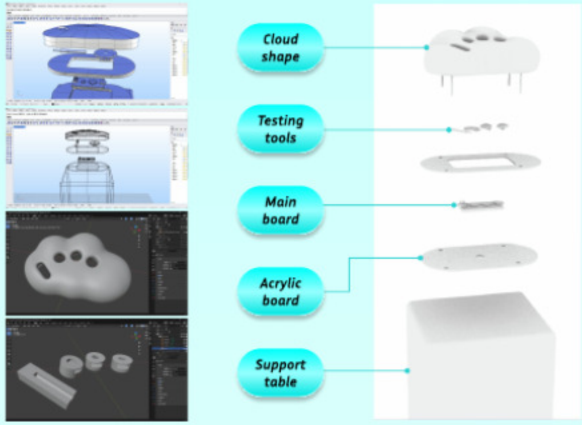


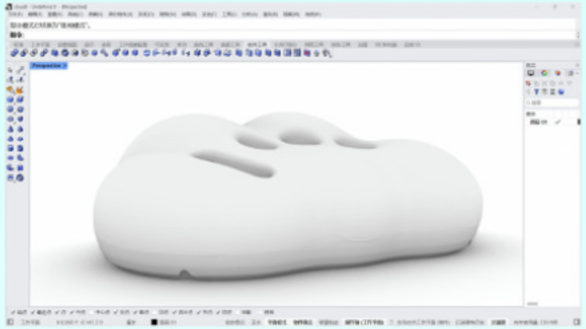
Structural erection
Connect the component's circuit downward.

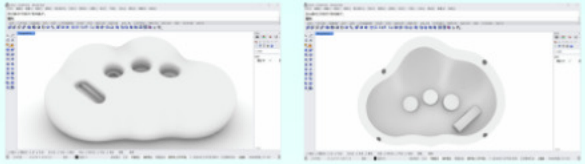
Preliminary testing
Complete model fabrication and conduct testing



Sketch







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

02 / WEARABLE SAFETY SYSTEM

VIGIL

滑雪疲劳预警 · sEMG · 可穿戴交互

VIGIL
是一套为滑雪者设计的可穿戴肌肉疲劳预警系统。腿部装置采集股外侧肌的表面肌电信号，经 ESP32-C6 处理 RMS、MDF、MNF
等特征，并与个人基线比较；雪镜界面和触觉反馈提供稳定、减速、休息三级提示，帮助用户在动作控制下降前识别风险并及时调整。

Background

Muscle Fatigue

Injury Prevention

Skiing Safety

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.

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)

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

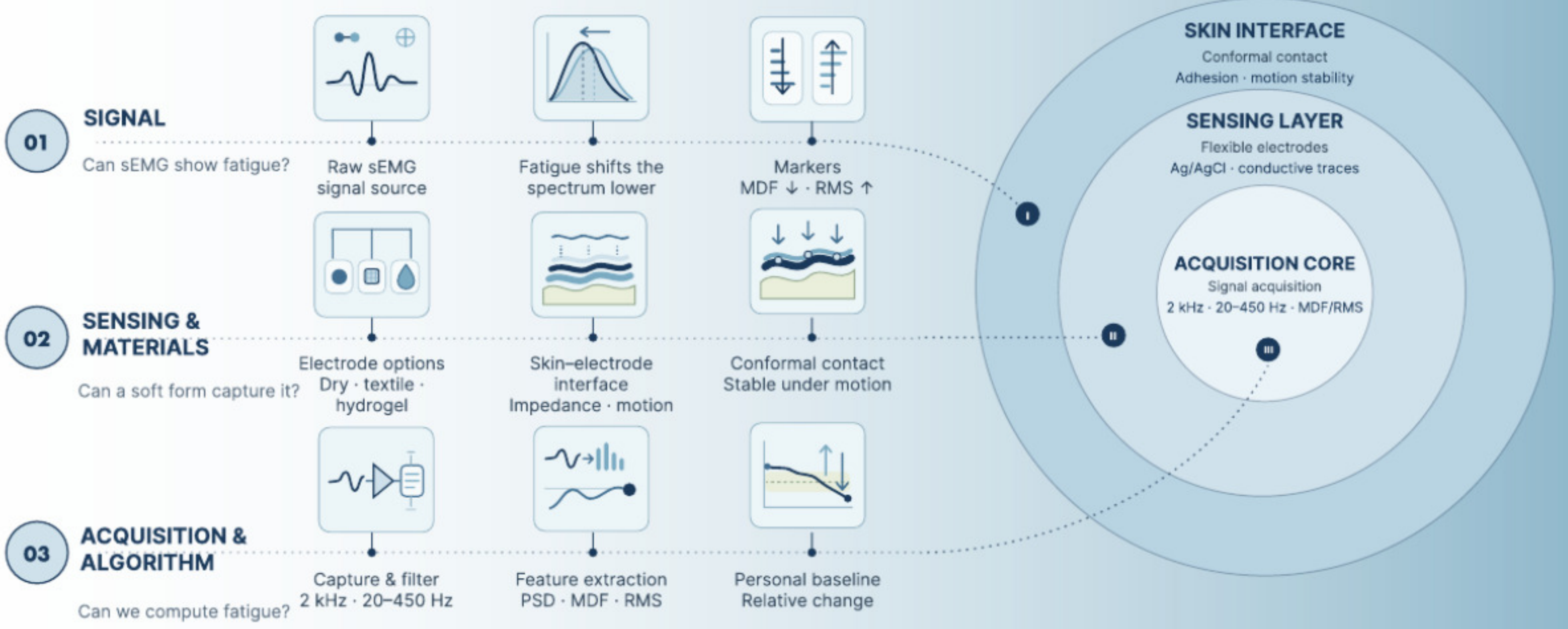
My worst falls always come on the last run — my legs are done, but I always want just one more.

"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



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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.

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

sEMG patch + haptic core

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

02 PART 02 — IN THE VIEW

HUD at the edge of sight

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

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 — **OYMotion** · AMPLIFY — **Gravity EMG** · SAMPLE — **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

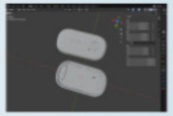
No USB tether during use. ESP32-C6 sends live sEMG to the web UI and future AR cue.

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.

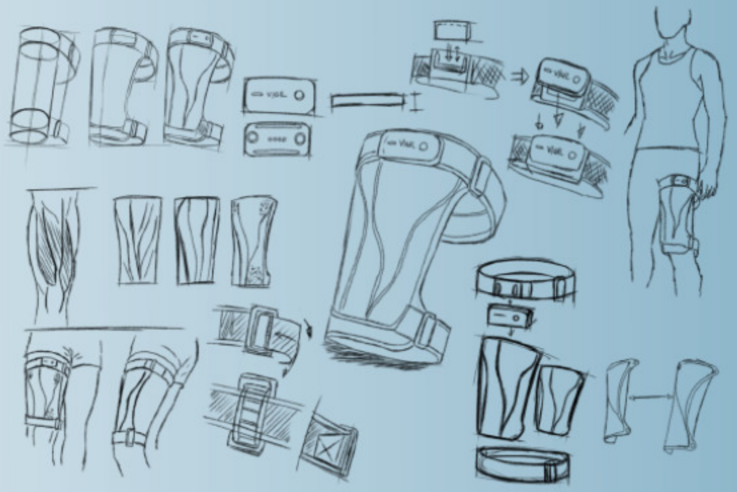
05 / SIGNAL CAPTURE
Captured the first raw sEMG signal and displayed its live waveform.

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

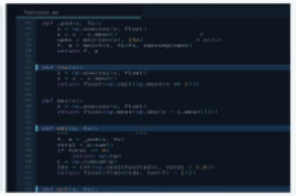
The sensor streams 2,000 samples per second. Filtering removes motion and mains noise before analysis.

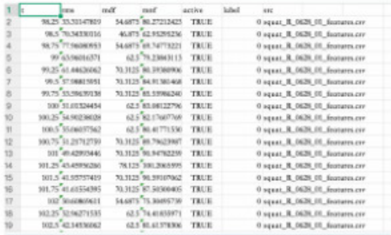
RAW sEMG → CLEAN SIGNAL

02 / CALCULATE

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

RMS ↑ / MDF ↓



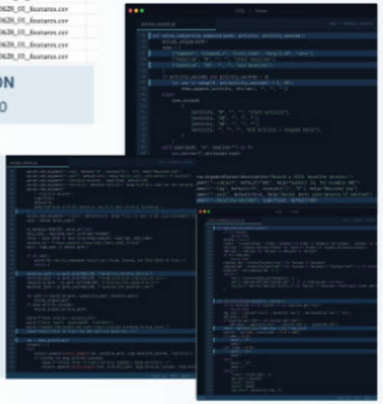


03 / LABEL + STORE

Feature rows are paired with fatigue state and source.

BORG 0–10 / REAL SESSION

30 s = 5 · 45 s = 8 · 65 s = 10



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

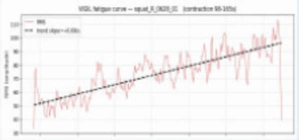
PHYSIOLOGY
RMS · MDF · MNF

SELF-REPORT
Borg 0–10

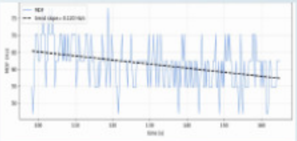
CONTEXT
activity · duration

MULTIMODAL LEARNING CONCEPT
Explore shared fatigue patterns and calibrate future thresholds.

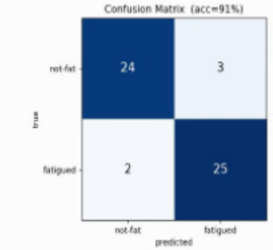
EVIDENCE FROM THE FIRST LABELED SESSION

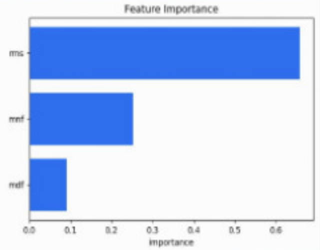


RMS rises with effort.



MDF falls with fatigue.





91% Proof of feature separability — not population accuracy.

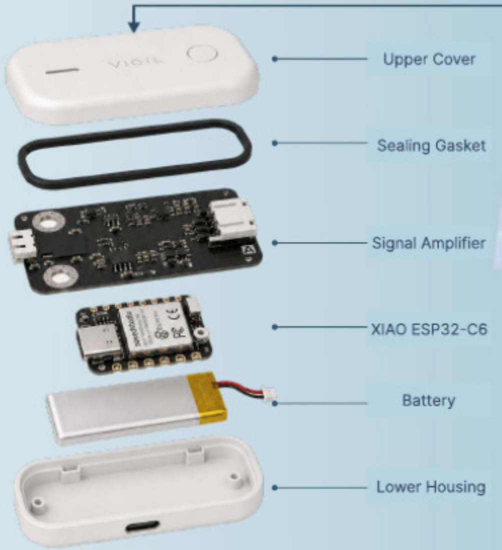
LEARNING LAYER discovers patterns + calibrates thresholds
LIVE BASELINE adapts the system to today's individual

COMBINED OUTPUT

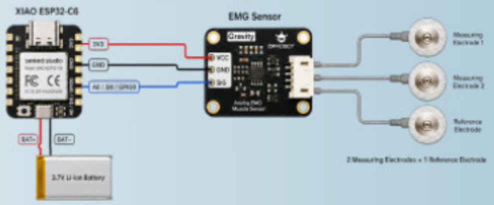
30 s daily reference + learned feature knowledge = personalised fatigue intelligence

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	L2 / REDUCE	L3 / RECOVER
CONTI NUE	SLOW DOWN	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

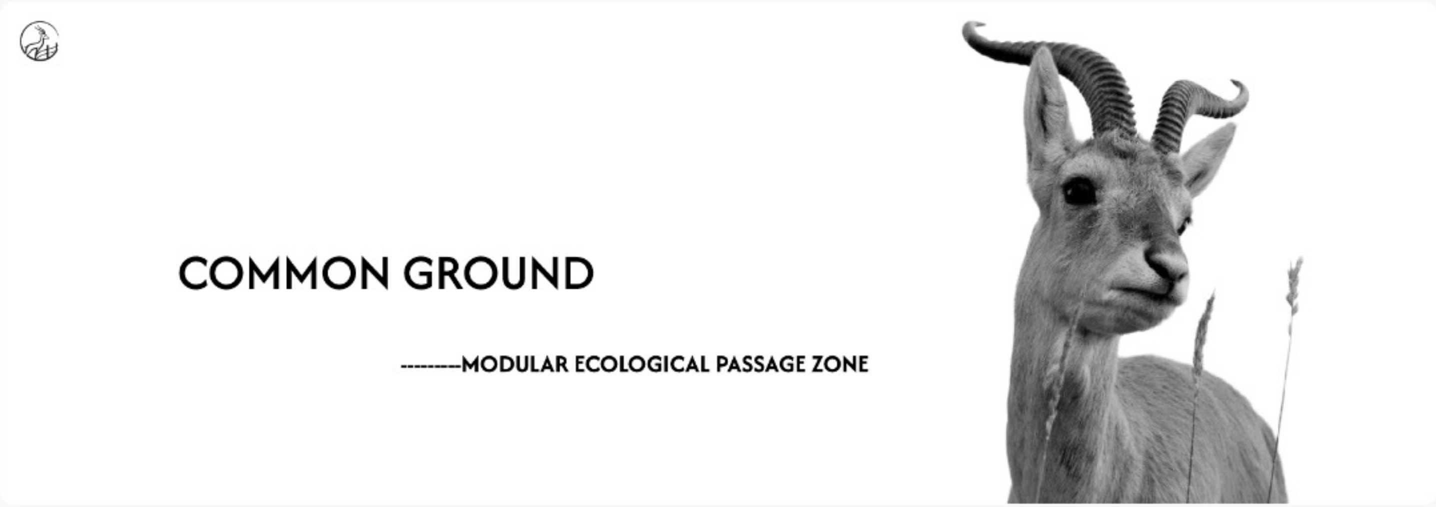
VIGIL currently delivers feedback through a concise visual interface integrated into smart ski goggles. Future iterations will explore haptic alerts and coordinated feedback across additional wearable touchpoints. Together, they can evolve VIGIL into a connected ski system that senses fatigue, helps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

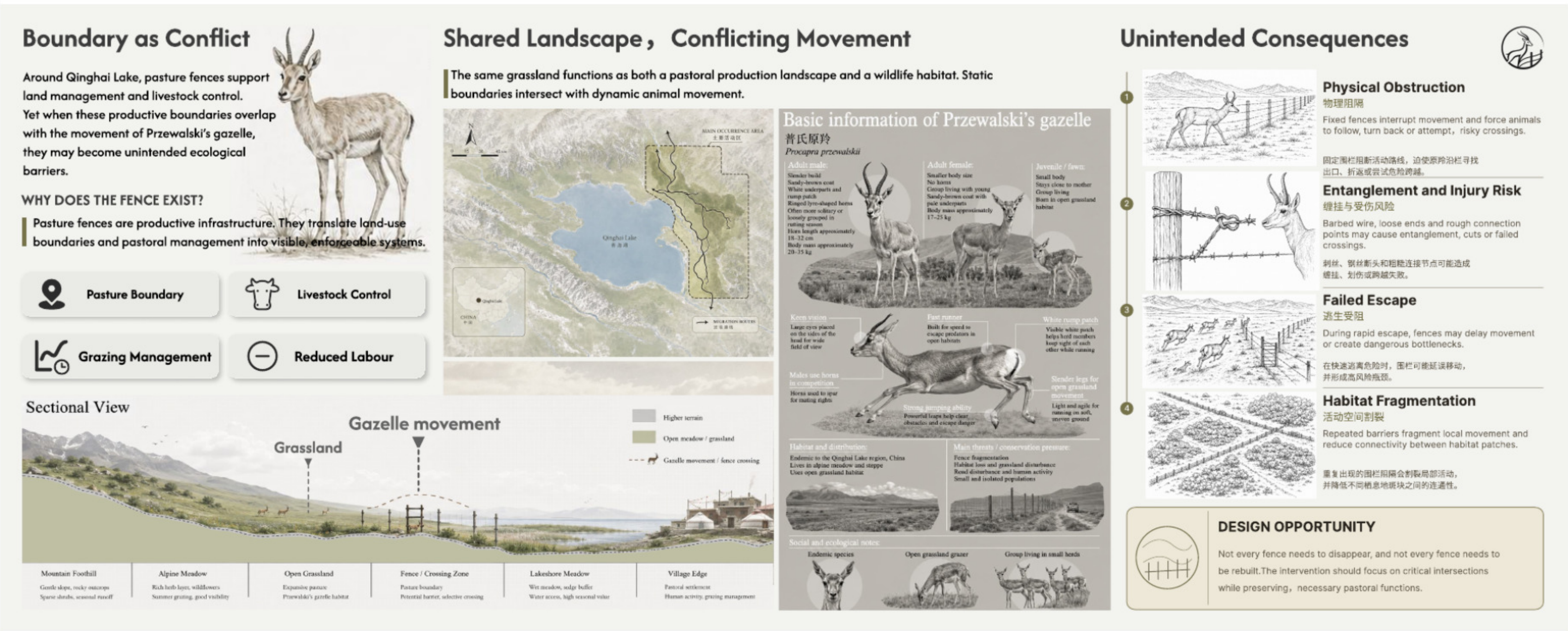
SENSE · PROTECT · ENHANCE THE EXPERIENCE

Common Ground

生态连通 · 模块化通道 · 维护机制

Common Ground
关注青海湖牧场围栏与普氏原羚迁移之间的冲突。项目从围栏管理、动物通行和多方维护责任出发，提出嵌入现有围栏的模块化生态通道。方案通过可调上下栏体形成通行空间，由低功耗相机辅助监测，并记录开合、复位与维修状态，在保留牧业管理功能的同时提升生态连通性与长期可维护性。




Boundary as Conflict
Around Qinghai Lake, pasture fences support land management and livestock control.
Yet when these productive boundaries overlap with the movement of Przewalski's gazelle, they may become unintended ecological barriers.
WHY DOES THE FENCE EXIST?
Pasture fences are productive infrastructure. They translate land-use boundaries and pastoral management into visible, enforceable systems.
Pasture Boundary
Livestock Control
Grazing Management
Reduced Labour
Shared Landscape， Conflicting Movement
The same grassland functions as both a pastoral production landscape and a wildlife habitat. Static boundaries intersect with dynamic animal movement.
Basic information of Przewalski's gazelle
普氏原羚
Procapra przewalskii
Adult male:
Slender build
Sandy-brown coat
White underparts and rump patch
Ringed lyre-shaped horns
Often more solitary or loosely grouped in rutting season
Horn length approximately 18–32 cm
Body mass approximately 20–35 kg
Adult female:
Smaller body size
No horns
Group living with young
Sandy-brown coat with pale underparts
Body mass approximately 17–25 kg
Juvenile / fawn:
Small body
Stays close to mother
Group living
Born in open grassland habitat
Keen vision
Large eyes placed on the sides of the head for wide field of view
Fast runner
Built for speed to escape predators in open habitats
White rump patch
Visible white patch helps herd members keep sight of each other while running
Males use horns in competition
Horns used to spar for mating rights
Strong jumping ability
Powerful leaps help clear obstacles and escape danger
Slender legs for open grassland movement
Light and agile for running on soft, uneven ground
Habitat and distribution:
Endemic to the Qinghai Lake region, China
Lives in alpine meadow and steppe
Uses open grassland habitat
Main threats / conservation pressure:
Fence fragmentation
Habitat loss and grassland disturbance
Road disturbance and human activity
Small and isolated populations
Social and ecological notes:
Endemic species
Open grassland grazer
Group living in small herds
Sectional View
Gazelle movement
Grassland
Higher terrain
Open meadow / grassland
Gazelle movement / fence crossing
Mountain Foothill
Gentle slope, rocky outcrops
Sparse shrubs, seasonal runoff
Alpine Meadow
Rich herb layer, wildflowers
Summer grazing, good visibility
Open Grassland
Expansive pasture
Przewalski's gazelle habitat
Fence / Crossing Zone
Pasture boundary
Potential barrier, selective crossing
Lakeshore Meadow
Wet meadow, sedge buffer
Water access, high seasonal value
Village Edge
Pastoral settlement
Human activity, grazing management
Unintended Consequences
1
Physical Obstruction
物理阻隔
Fixed fences interrupt movement and force animals to follow, turn back or attempt，risky crossings.
固定围栏阻断活动路线，迫使原羚沿栏寻找出口、折返或尝试危险跨越。
2
Entanglement and Injury Risk
缠挂与受伤风险
Barbed wire, loose ends and rough connection points may cause entanglement, cuts or failed crossings.
刺丝、钢丝断头和粗糙连接节点可能造成缠挂、划伤或跨越失败。
3
Failed Escape
逃生受阻
During rapid escape, fences may delay movement or create dangerous bottlenecks.
在快速逃离危险时，围栏可能延误移动，并形成高风险瓶颈。
4
Habitat Fragmentation
活动空间割裂
Repeated barriers fragment local movement and reduce connectivity between habitat patches.
重复出现的围栏阻隔会割裂局部活动，并降低不同栖息地斑块之间的连通性。
DESIGN OPPORTUNITY
Not every fence needs to disappear, and not every fence needs to be rebuilt.The intervention should focus on critical intersections while preserving，necessary pastoral functions.

Field observation

Field observation and interviews with pastoral communities around Qinghai Lake

Before redesigning the fence, the project investigated how it is used, maintained and negotiated in everyday pastoral life.

Data collection

STAKEHOLDER INTERVIEWS

Listening to the people who keep the boundary working

Before redesigning the fence, I investigated how it is used, maintained and negotiated in everyday pastoral life around Qinghai Lake.

WHAT WE LEARNED

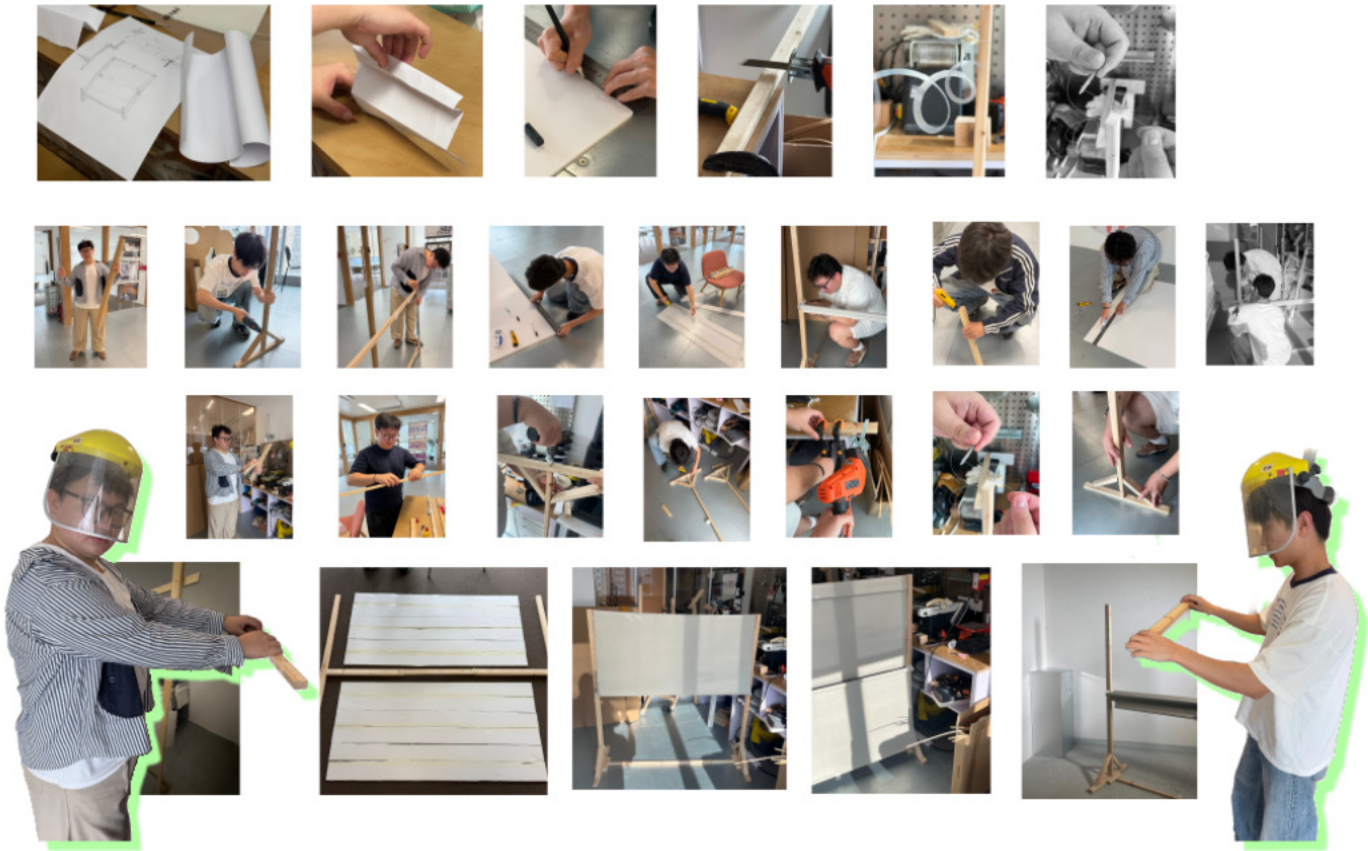
01 | The fence is not the enemy
The conflict comes from a fixed, single-purpose boundary meeting seasonal and multi-species movement.
02 | Permeability must be conditional
The boundary should open at the right place and time, without creating uncontrolled livestock escape.
03 | Maintenance is part of the design
A passage without inspection, ownership and repair can fail invisibly over time.

DESIGN OPPORTUNITY

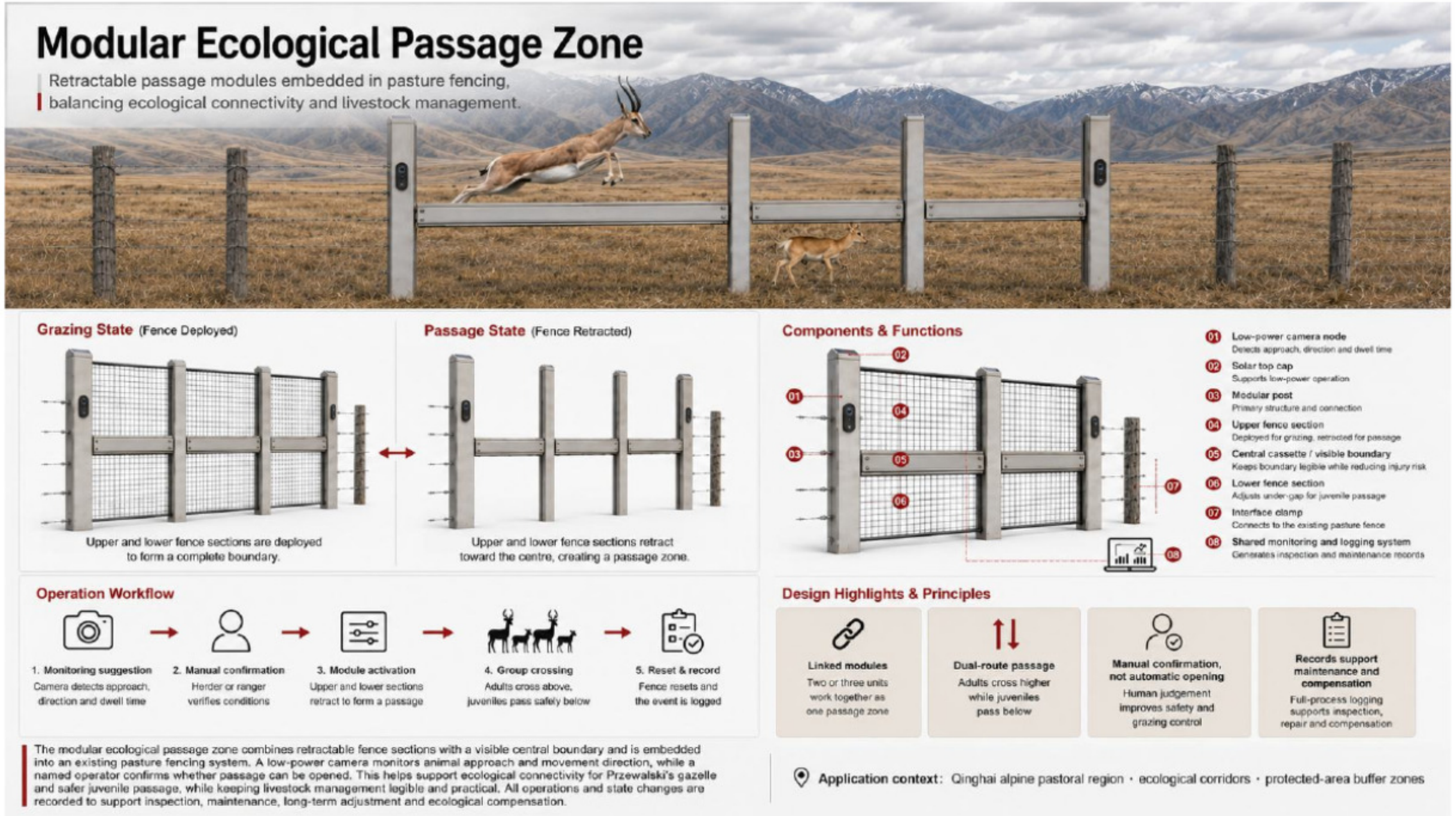
How might we create a boundary that remains legible and controllable for herders, while becoming permeable when and where gazelles need to pass?


STAKEHOLDERS
Who is affected by, dependent on, or responsible for the existing pasture fence
Protected-area administration
sets conservation and land-use rules
Natural predators
may exploit fence corners and constrained escape routes
Przewalski's gazelle
is blocked, diverted and exposed to injury
Forestry Bureau
balances wildlife protection with contracted grassland management
Environmental NGO
advocates for habitat connectivity and community participation
Herder household
depends on it for livestock and boundary control
Sheep & yak
are contained by it
EXISTING PASTURE FENCE
Township & village
mediates responsibility and boundary conflicts
Grassland ranger
inspects manually, often without reliable state information
Protection station
lacks continuous evidence that modified crossings remain usable
Road & railway authority
manages infrastructure that intersects habitat links
Research institute
needs reliable passage and maintenance data
Inner ring — directly affected by, dependent on, or responsible for inspecting the existing fence.
Outer ring — governs, studies or indirectly shapes how the fence operates and what risks it creates.
The existing pasture fence is not a single-species problem. It blocks gazelle movement, contains livestock, marks contracted boundaries and creates inspection and evidence burdens for local institutions. Its ecological costs, productive value and maintenance responsibilities are distributed across different actors, while no single actor can resolve the conflict alone.
DESIGN IMPLICATION
The design challenge is to determine where, when and under whose responsibility the boundary can become 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 a few kilometres of shoreline into a search problem. Facing it, the gazelle walks, looking for a way through that may not exist.
Daily movement falls 7,223 m → 4,110 m.
02
The wire itself does the injuring
Barbs and a slack bottom strand catch an animal that is already committed to the gap. Corners are worse: a fleeing animal cannot change direction and is pressed into the line.
Entanglement deaths and kills at fence corners are on record — mortality that has nothing to do with grazing.
03
Removal asks the herder to give up control
The fence is the proof of a contracted boundary and the reason livestock stay put. Taking it down removes a working tool and hands back nothing, so the offer is refused.
Would accept removal: 20.78% → 34.21% if framed as protection → 40.79% with compensation (n=141).
04
A modification cannot prove it still works
Wire slackens, snow fills the gap, someone closes it back. Nothing on the fence reports its own state, so an opening can stop working for a whole season without anyone knowing.
16 gaps of about 4 m (2008) and 8 railway culverts (2007–2009) showed no clear crossing.
WHAT IT HAS TO DO INSTEAD — the brief, in four lines
01
Let them through without taking it down
The boundary stays where it is, still readable as a contract line, still able to hold stock.
02
Create a broad passage zone, not a single narrow opening
A low gap a juvenile gazelle can walk under, and a barb-free line low enough for an adult to cross.
03
Show and record its own state
Each bay displays its clearance and lock state mechanically, while the system records which bays were opened, how they were configured and whether animals actually used them
04
Pay for upkeep, not for demolition
Checking, operating, resetting and repairing are compensated through verified records—not by metres of fence removed.
ONE SENTENCE
The fence does not fail simply because it exists. It fails because it is continuously closed, spatially uniform, injurious at points of contact and unverifiable over time. The response must therefore create a broad, adjustable and accountable passage zone rather than one isolated gap
CONCEPT
MODULAR ECOLOGICAL PASSAGE ZONE
Two or three linked gate modules create one broad, visible and adjustable passage zone.
01 THE MODULAR GATE
Two or three bays form one passage zone.
Upper and lower sections retract independently.
Shared posts allow separate bay settings.
Existing fences remain in place.
02 SENSING
One low-power camera monitors all bays
Tracks approach, direction and dwell time.
Records crossings and species.
Tracks each bay's state and faults.
03 OPERATION
The system recommends a passage window.
A named operator confirms
Opening and closing are logged.
Reset follows group-clear confirmation.
IS A PASSAGE WINDOW RECOMMENDED
CAN LIVESTOCK BE SAFELY CONTROLLED?
GRAZING STATE
All bays remain deployed and locked. Boundary and livestock control continue while monitoring stays active
PASSAGE CONFIGURATION
Select one, two or three bays. Lower sections create adjustable under-gaps, while upper sections reduce crossing height
EVERY BAY AND ACTION BECOMES A RECORD
inspection · bay selection · configuration · reset · fault · repair
VERIFIED MAINTENANCE COMPENSATION
Paid for checking, operating and repairing—not by metres removed.
Each record improves the next inspection, passage setup and maintenance cycle.
The modular ecological access belt consists of two to three connected gate units embedded within the existing ranch fence. Each unit is equipped with a fixed central storage box, and the upper and lower railings allow independent storage. The system is responsible for recommending passage time windows and module configuration, but the designated herders or patrol officers still perform fence operations after inspecting livestock management conditions. The shared low-power cameras record animal approach, movement direction, route selection, actual passage, and the status of each module. Once the camera has identified the animal group and the relevant personnel confirm the safety of the passage, all modules are restored to grazing mode. Verified inspection, operation, and maintenance records will be used for maintenance compensation and subsequent plan adjustments.

Design Process



Prototype


Modular Ecological Passage Zone
Retractable passage modules embedded in pasture fencing, balancing ecological connectivity and livestock management.
Grazing State (Fence Deployed)
Upper and lower fence sections are deployed to form a complete boundary.
Passage State (Fence Retracted)
Upper and lower fence sections retract toward the centre, creating a passage zone.
Components & Functions
01 Low-power camera node
Detects approach, direction and dwell time
02 Solar top cap
Supports low-power operation
03 Modular post
Primary structure and connection
04 Upper fence section
Deployed for grazing, retracted for passage
05 Central cassette / visible boundary
Keeps boundary legible while reducing injury risk
06 Lower fence section
Adjusts under-gap for juvenile passage
07 Interface clamp
Connects to the existing pasture fence
08 Shared monitoring and logging system
Generates inspection and maintenance records
Operation Workflow
1. Monitoring suggestion
Camera detects approach, direction and dwell time
2. Manual confirmation
Herder or ranger verifies conditions
3. Module activation
Upper and lower sections retract to form a passage
4. Group crossing
Adults cross above, juveniles pass safely below
5. Reset & record
Fence resets and the event is logged
Design Highlights & Principles
Linked modules
Two or three units work together as one passage zone
Dual-route passage
Adults cross higher while juveniles pass below
Manual confirmation, not automatic opening
Human judgement improves safety and grazing control
Records support maintenance and compensation
Full-process logging supports inspection, repair and compensation
The modular ecological passage zone combines retractable fence sections with a visible central boundary and is embedded into an existing pasture fencing system. A low-power camera monitors animal approach and movement direction, while a named operator confirms whether passage can be opened. This helps support ecological connectivity for Przewalski's gazelle and safer juvenile passage, while keeping livestock management legible and practical. All operations and state changes are recorded to support inspection, maintenance, long-term adjustment and ecological compensation.
Application context: Qinghai alpine pastoral region · ecological corridors · protected-area buffer zones