Halo – Improve Wellbeing with Smart Integration

A Project by Jakob Gutersohn, Valéry Piot, David Bänzinger and Bhupinder Singh

Content

Introduction

We are Kirchenfeldrobotics, a small team of passionate robotics nerds with real-world experience and a strong competition track record. We've won multiple medals at the World Robot Olympiad, placed 2nd at BärnHackt among 35 top-tier teams, and our

Our Team Logo

Swiss{AI}Weeks project was even featured on SRF's 10vor10. We are tackling challenges with creativity and team spirit, which has earned us several team and audience awards.

Midway through this hackathon, we met Bhupinder, his team left him alone, so we decided to welcome him to ours. It's part of how we work: open, adaptable, and collaborative.

We chose this challenge because we want to build a long-term, real-world solution, not just another weekend prototype. Halo reflects our strengths: robotics, usability, and scalable innovation.

We're excited to keep developing it beyond the hackathon, because we think it fills a critical gap in spaceflight, especially for the commercial spaceflight industry.

The Problem

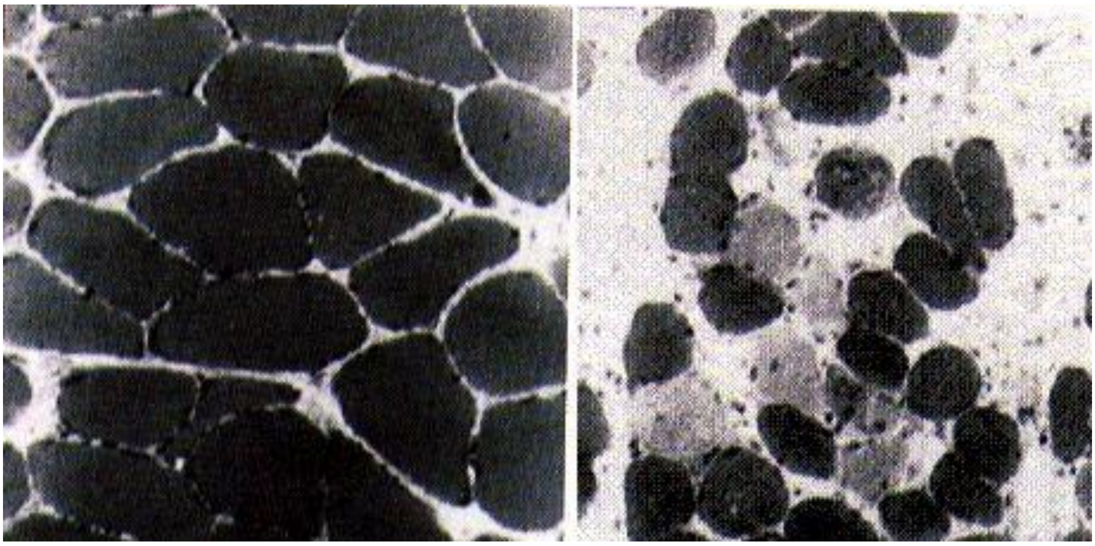
We invested a lot of time in finding the perfect problem that ideally fits our team's skillset and eventually discovered an overlooked gap in the market.

One of the biggest challenges in manned space missions is the human aspect. The wellbeing of astronauts is crucial to mission success, **yet there are still major gaps in this field**, especially in mental health, but also in untapped opportunities for physical wellbeing. This Problem also gains relevance in the private sector because the astronauts need to comply with the regular work regulations.

Physically:

- Astronauts lose up to **20% of muscle mass** in just **5 to 11 days** of spaceflight.
- The impact is most **severe in weight-bearing muscles**, legs, back, and core.

- Astronauts train for **2 hours or more every day**, which takes up a lot of valuable time.
- **17% of astronauts** still experience significant muscle loss, and all are affected to some degree.
- Without countermeasures, astronauts lose **1% of bone density per month**.



Muscle Tissue before (left) a space mission and after (right)

Mentally:

- Cognitive fatigue due to stress, sensory monotony, and confinement.
- Isolation and mood disorders are common.
- Lack of privacy, disrupted sleep rhythms, and limited social contact have a huge impact on performance and wellbeing.

Effects:

- Slower and less accurate decision-making.
- Reduced reaction time.
- Difficult group dynamics and communication.

For the mental part, personalized tools are a big topic, NASA and ESA are both actively researching solutions in this area.
For the physical part, there is surprisingly little ongoing innovation. It's mostly accepted that astronauts just must do 2 or more hours of exercise every day.

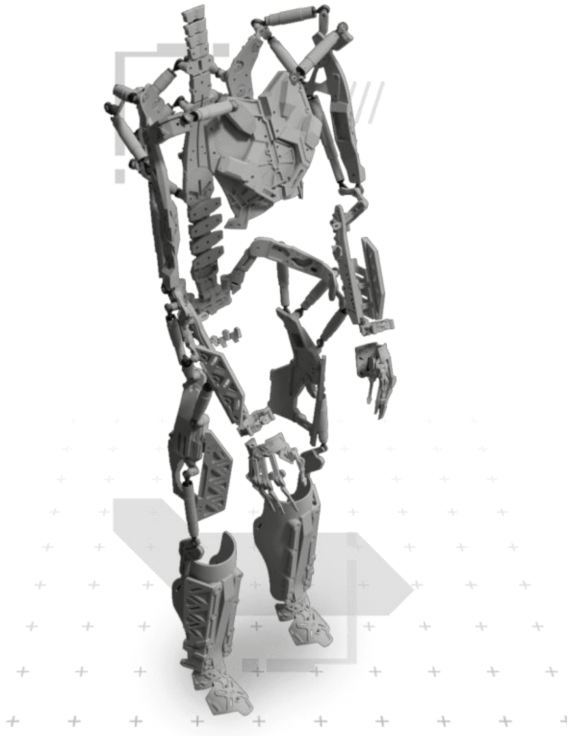
And this is where we step in. We built an innovative platform that combines mental and physical wellbeing, using a smart exoskeleton and a personalized wellbeing system that adapts based on movement and sensor data. What sets us apart is that we integrate the exoskeleton's physical data directly into the mental support system, creating a feedback loop that not only improves wellbeing but also actively addresses the physical challenges astronauts face.

Our Solution

Our Solution features two main parts: an Application and the Exoskeleton

Those parts are seamlessly integrated to work reliably together. And being as user friendly as possible. To take work away from astronauts. Therefore, we also decided on prototyping our own application, so the exoskeleton and the halo P can be used intuitively.

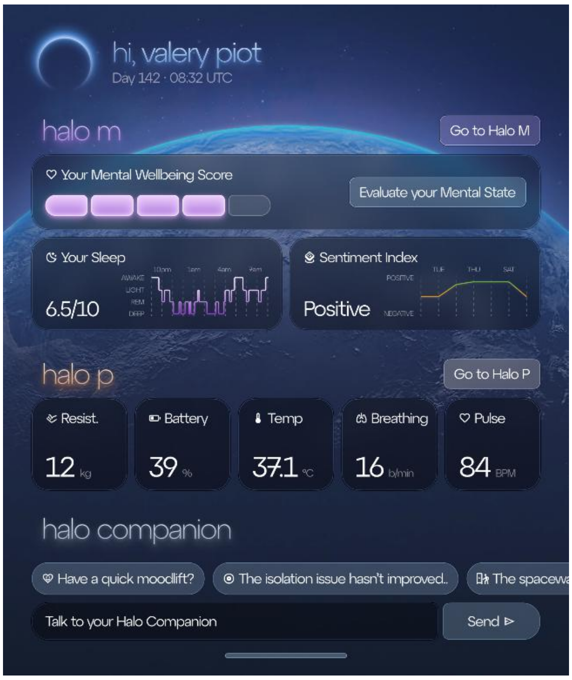
Exoskeleton



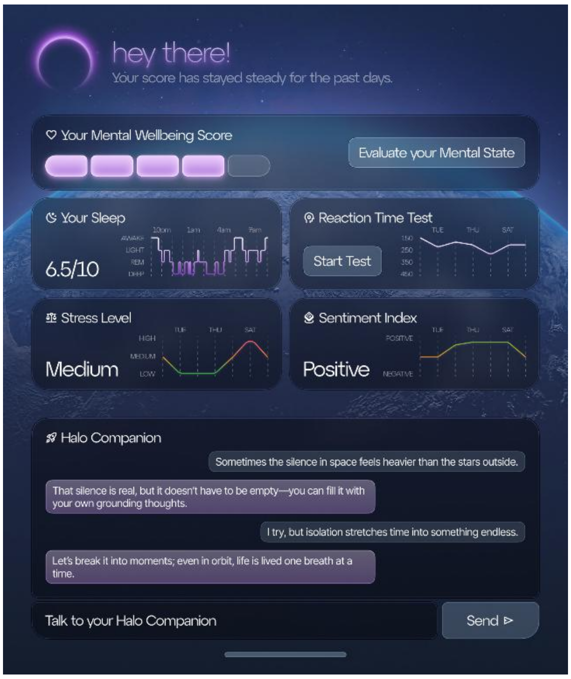
Render of a possible Exoskelett

As we didn't have much time during the Hackathon, we decided to feature a prebuilt 3D model that we found online for rendering. If we were to build a prototype, it would include integrated sensors. The exoskeleton is strapped to the human body using Velcro fasteners, making it user-friendly and easy to wear. The system includes an app interface where resistance levels can be adjusted, and additional settings configured. From the physical wearing experience to the digital interface, the entire exoskeleton is designed with user friendliness as a core priority.

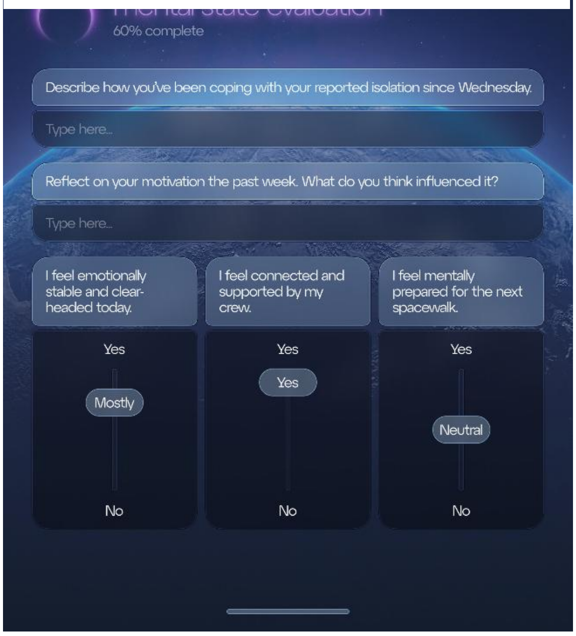
Our Application



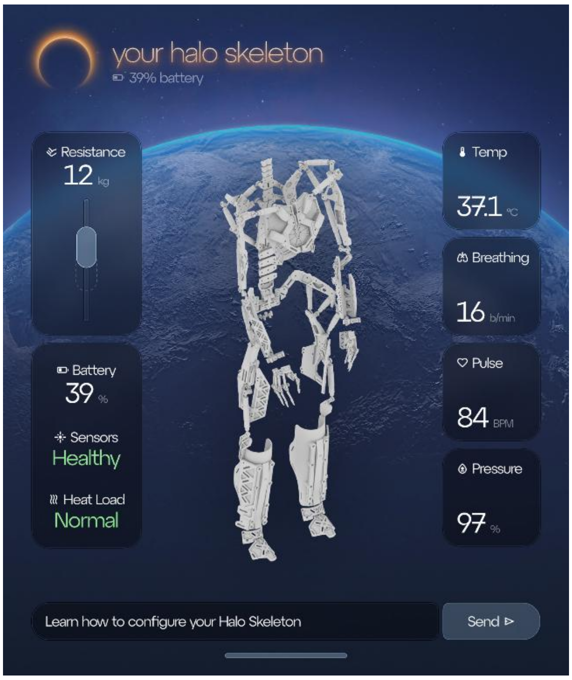
Page 1: Dashboard with facts from Halo P and Halo M



Page 2: The Halo M site with all the interpreted Data



Page 3: The Mental health is evaluated daily



Page 4: The Exoskeleton page where you can control the system

Our application aims to combine the Halo M and Halo P modules into a seamless integration. The mental component of the app consists of a form to evaluate your mental health. By answering the questions in the app, you train your custom AI model. The next day, the questions adapt to your previous responses and current struggles.

The key feature that sets our approach apart from existing apps is the integration of medical data from the exoskeleton into the AI evaluation. This allows the system to correlate physical indicators, such as heart rate variability, respiration, and stress markers, with mental health trends. If the AI detects a decline in wellbeing, it can redirect the user to a therapist on Earth, who receives the evaluated data to provide targeted support.

Another important feature is that our AI evaluation enables external experts to gain insight into an astronaut's health status, crucial for mission success and crew safety. The app is designed to be as intuitive and user-friendly as possible and also features a direct AI chat, an agentic AI optimized to be present, responsive, and supportive.

By using this approach, we make the exoskeleton more accessible while simultaneously enhancing mental health through integrated biometric feedback. It's a two-sided gain: physical support and psychological resilience, working together.

Impact & Potential

Regular Training devices take up a lot of Space.

The potential and impact of our solution is huge. In the private space sector, there's a clear market gap, not only for astronaut exoskeletons, but especially for systems that combine physical support with smart mental wellbeing tools. We don't just fill that gap, we redefine it.
By integrating exoskeleton data into a personalized wellbeing app, we create a completely new way of analysing astronaut health that goes far beyond what current mental health companies offer.
This Tool is especially valuable as it offers a direct insight into an astronaut's wellbeing, with detailed insights into physical and mental health, making it truly invaluable.

The industry has a massive interest in these topics, because our solution:

- Saves time → more research, more rest, more productivity
- Saves resources and space → lower cost and more space on station

- Addresses muscle atrophy → astronauts lose up to **50% of their strength** during a six-month mission
- Improves endurance and reduces recovery time after missions

➔ **Drives down cost, while creating more space on the station and offering an invaluable insight into an astronaut's wellbeing.**

Innovation & Research

With our project, we've chosen to build on concepts that are already **backed by years of research, but surprisingly, haven't been fully developed or applied** in astronaut life. Both physical and mental wellbeing have been studied extensively in space medicine, yet most solutions remain isolated, experimental, or underutilized. **Halo bridges that gap.**

Mental Wellbeing: Proven by Research

This is some of the most important research on this topic:

- **Virtual Reality (VR):** ESA's VR Mental Care experiment showed that immersive environments significantly reduce stress and improve mood. Astronaut Andreas Mogensen used the VIVE Focus 3 headset aboard the ISS, reporting better relaxation and motivation.
- **Circadian Light Systems:** ESA's Circadian Light project mimics Earth's natural light cycles to regulate sleep and reduce stress. Results showed improved sleep quality and reduced fatigue, as well as an improved efficiency.
- **Meditation & Mindfulness Apps:** SpaceX and NASA have tested guided meditation tools optimized for zero-gravity. These apps use biometric feedback to personalize sessions and have shown measurable reductions in stress levels.
- **Crew Earth Observations:** Astronauts taking photos of Earth from the ISS cupola reported improved mental wellbeing and reduced feelings of isolation.
- **NeuroMapping:** NASA's brain imaging studies revealed significant changes in brain connectivity during missions, confirming the need for proactive mental health support.

The existing Tools work, but they're fragmented. Halo integrates the best parts of them into one adaptive system, personalized through real-time exoskeleton data.

Physical Wellbeing: Concepts but no real world deployment

The NASA X1 Exoskeleton was never fully deployed

NASA's X1 Exoskeleton, developed together with IHMC, was an important step toward space resistance training. It featured actuators at the hips and knees, adjustable torque, and real-time feedback. However:

- It was never fully deployed or integrated into astronaut suits.
- It lacked smart adaptation and personalized feedback loops.
- It was designed more for mobility assistance than active resistance training.
- It remained a prototype, with no commercial or operational follow-up.

There also are also a lot of normal exoskeletons that support people with movement, but those aren't optimized for resistance training. Therefore, NASA remains the only one to have built a prove of concept.

Conclusion: From Research to Real-World Impact

There's no shortage of research or prototypes in astronaut wellbeing. Mental health tools like VR, light therapy, and mindfulness have shown measurable benefits. Physical solutions like NASA's X1 exoskeleton and ARED have proven the need for resistance training in microgravity. **But despite all this, these tools remain fragmented, bulky, or stuck in prototype stages. Halo combines those prototypes and builds on top of this proven concept.**

Technical Solution & Implementation

Our technical Solution is based on a Suite, called “Halo Suite”.

This Suite currently consists of two subparts: Halo M, and Halo P

We choose this approach because we think it is scalable, provides a good image while looking like a professional product line up.

In the following part, we will show you how we made the first design of our exoskeleton during the Hackathon and how Halo M works behind the scenes. We will also show you how our central Application “Halo Suite” works.

Halo P – Physical, Exoskeleton and integrated Sensors

We decided that the combination of these sensors make sense:

- **PPG (Photoplethysmography)** – Heart Frequency (HF), Heart Frequency Variability (HRV), oxygen saturation (SpO_2).
- **ECG Sensor (Electrocardiography)** – as a stress detector and improving precision of HF and HRV
- **EDA/GSR Sensor (Electrodermal Activity / Galvanic Skin Response)** – measures stress and emotions
- **Skin Temperature Sensor** – stress, fatigue, and circadian rhythm
- **Respiration Sensor** motion sensor in form of f.e. a chest strap

With these sensors, we can improve the tracking of our Halo M software and make it more precise

Exoskeleton QDD Actuator by Maxon

For Halo's physical structure, we chose to use Quasi Direct Drive (QDD) actuators, which offer excellent backdrivability, high efficiency, and robust reliability. QDDs are already widely used in exoskeletons, and some have even been specifically designed for space applications, making them ideal candidates for future orbital deployment.

To simulate gravitational loading on the spine, we decided to use a motor-driven artificial spine using rope mechanisms. This setup allows us to emulate G-forces and spinal compression in a controlled way.

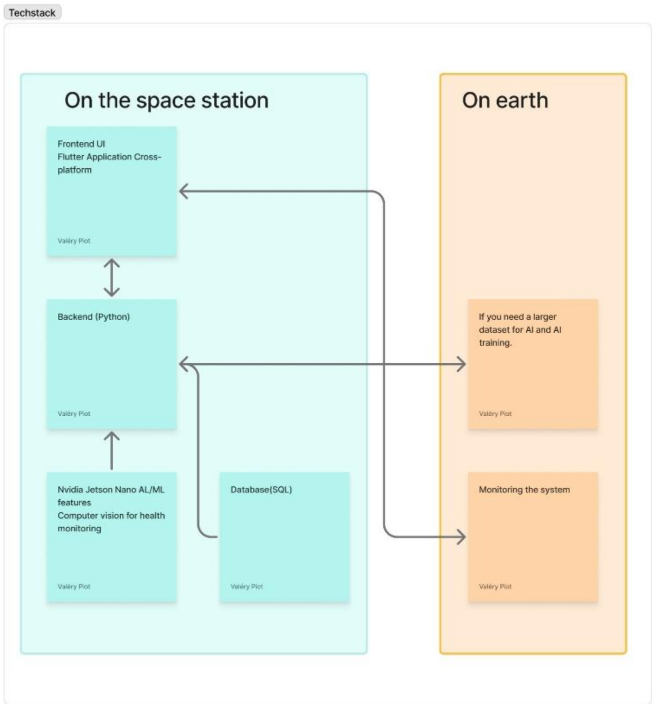
The joint design presents a unique challenge. We aim to achieve both (anti)exoskeleton capabilities and maximum degrees of freedom. This is essential to make the Exoskeleton feel natural but also having enough resistance to prevent muscle loss.

For the electronics we would have to make only a small PCB as we would choose a QDD with an integrated driver. The PCB would feature an ESP32, as it allows to connect wirelessly to a phone or computer over Bluetooth. This way, the data of the Exoskeleton and the App would remain synchronized while improving the user friendliness and accessibility.

The main rods would probably be made from aluminium or titan, depending on the strength needed. As there are already many components out there, we can build a cutting-edge exoskeleton by combining those parts. Because we choose electromagnetism as resistance, we can dynamically adjust the resistance in the application and therefore could also implement a smart training program or algorithms.

Halo M – Mental Wellbeing, personalized Tool

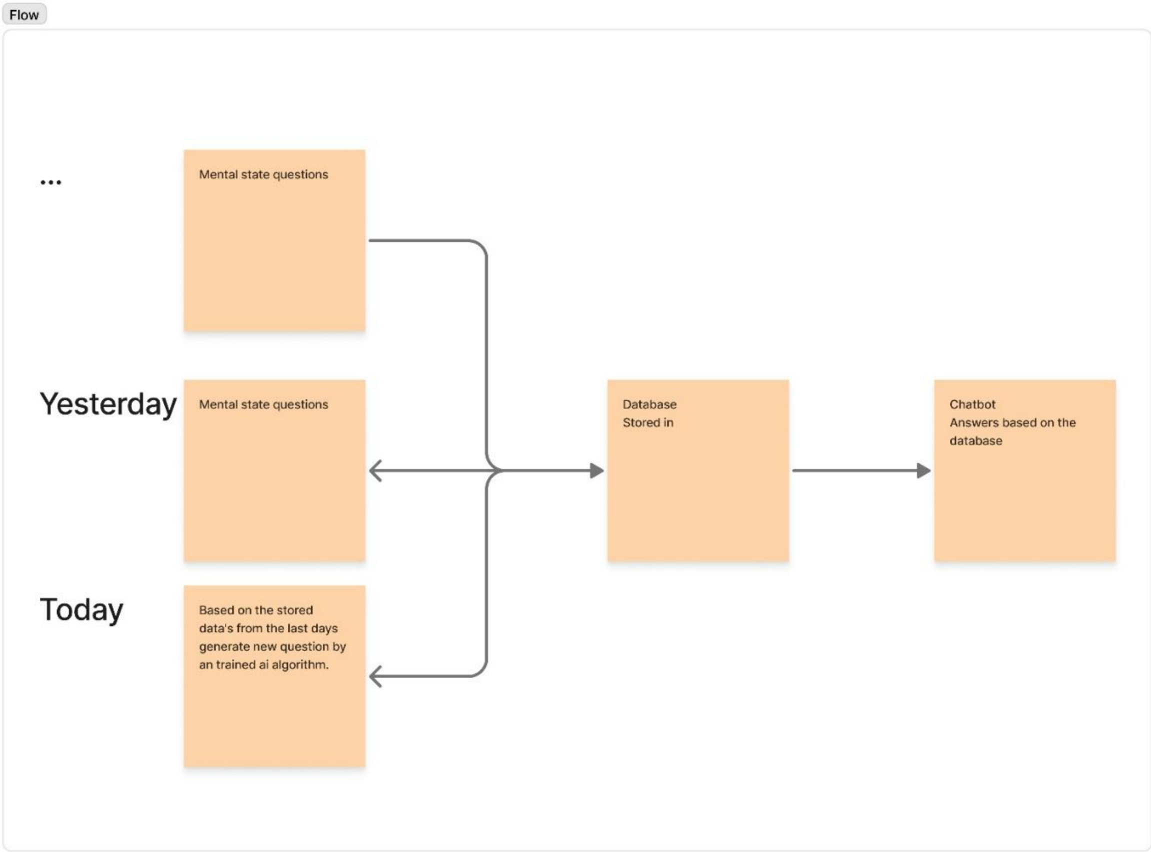
In this paragraph we explain how our application is working behind the front end and what functionality we are planning to implement.



Structure of the Application

Our application has its front end but also relies on servers. That's why we thought it would be necessary to include a server on the space station to decrease latency and improving user experience. This server would feature a phyton backend, as that also communicates with the ai part of our software. For missions that are far away from earth we would implement an ai chip, such as an Nvidia jetson nano to run the ai locally. Furthermore, the API connects to the local database.

Our application would only need external access when there is a larger ai model needed or if the system has to be monitored.



Front-end – Back-end Data Flow

We have multiple ideas on how to implement a smart algorithm. The idea we currently believe in is based on questions. The user gets asked questions and answers them. The next day, the questions adapt to the answers of the day before.

This is achieved by storing the data in a local database and by then providing the data to the LLM running on our local AI chip. We found that solution to be ideal, as it is user friendly, simple but also working very well as stated in NASA research.
We are also looking forward to picking up new ideas and implementing them into our software.

Interdisciplinary Synergy

Our project is extremely interdisciplinary. It combines cutting-edge robotics with the latest AI tools to optimize astronaut wellbeing. For Halo, seamless integration between hardware and software is crucial, and this fits perfectly with our team's skillset. We've developed our own PCBs, built countless prototypes, and have strong experience in software development. This is exactly what's needed to bring an interdisciplinary project like this to life.

Halo is also interdisciplinary when we look at the current landscape of solutions. It connects the dots between existing products to improve astronauts' lives.

Halo

- …bridges the gap between hardware and software
- …closes the gap between partly developed systems
- …gives ground stations better insight into astronauts' physical and mental health
- …opens up new possibilities for future research

In summary, our project shines especially in this interdisciplinary aspect.

Why it Matters

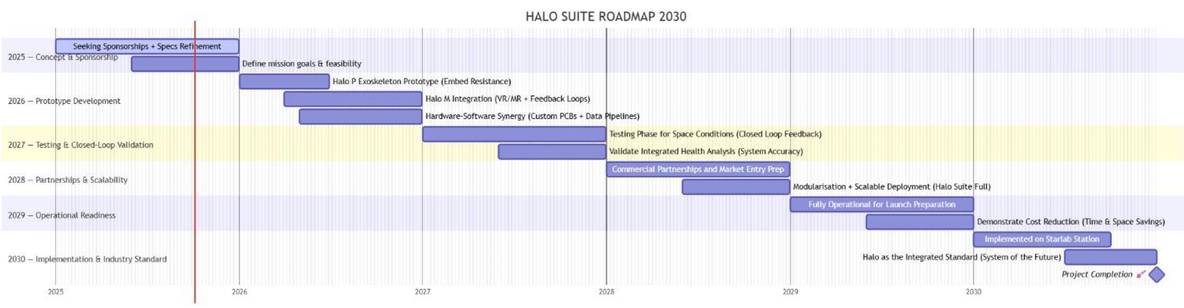
Astronauts are some of the most highly trained humans on Earth, yet in orbit, their bodies weaken, and their minds are pushed to the limit. Muscle atrophy, cognitive fatigue, and isolation aren't just side effects, they're mission risks. And as commercial spaceflight grows, these challenges will affect more people, more often.

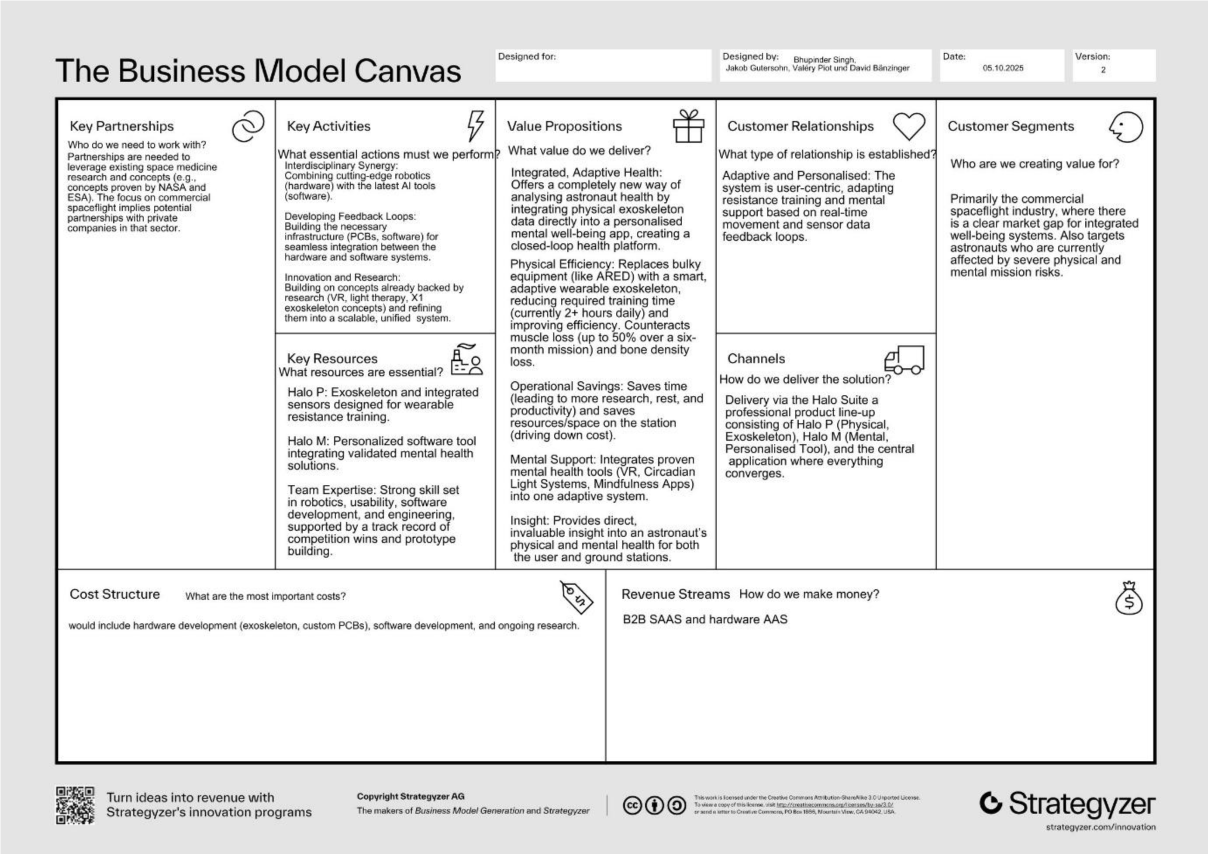
Halo matters because it reimagines astronaut wellbeing. It doesn't just track health, it supports it. By combining adaptive resistance training with personalized mental support, Halo gives astronauts back control over their bodies and minds. It saves time, reduces recovery, and improves performance, on orbit and back on Earth.

We believe wellbeing shouldn't be an afterthought. It should be built into the suit, the station, the system. Halo is our step toward that future.

Business and Roadmap

We would love to take Halo beyond the hackathon and develop it into a real-world solution. To show its startup potential, we created a Business Canvas that outlines how Halo could evolve into a scalable company and how well it fits the needs of the space and health tech industries. Our Roadmap presents a realistic timeline for development, testing, and deployment, showing exactly how we plan to turn Halo into a success.





The Business Model Canvas

Designed for:

Designed by: Bhupinder Singh, Jakob Gutersohn, Valéry Piot und David Bänzinger

Date: 05.10.2025

Version: 2

Key Partnerships

Who do we need to work with?
Partnerships are needed to leverage existing space medicine research and concepts (e.g., concepts proven by NASA and ESA). The focus on commercial spaceflight implies potential partnerships with private companies in that sector.

Key Activities

What essential actions must we perform?

Interdisciplinary Synergy: Combining cutting-edge robotics (hardware) with the latest AI tools (software).

Developing Feedback Loops: Building the necessary infrastructure (PCBs, software) for seamless integration between the hardware and software systems.

Innovation and Research: Building on concepts already backed by research (VR, light therapy, X1 exoskeleton concepts) and refining them into a scalable, unified system.

Key Resources

What resources are essential?

Halo P: Exoskeleton and integrated sensors designed for wearable resistance training.

Halo M: Personalized software tool integrating validated mental health solutions.

Team Expertise: Strong skill set in robotics, usability, software development, and engineering, supported by a track record of competition wins and prototype building.

Value Propositions

What value do we deliver?

Integrated, Adaptive Health: Offers a completely new way of analysing astronaut health by integrating physical exoskeleton data directly into a personalised mental well-being app, creating a closed-loop health platform.

Physical Efficiency: Replaces bulky equipment (like ARED) with a smart, adaptive wearable exoskeleton, reducing required training time (currently 2+ hours daily) and improving efficiency. Counteracts muscle loss (up to 50% over a six-month mission) and bone density loss.

Operational Savings: Saves time (leading to more research, rest, and productivity) and saves resources/space on the station (driving down cost).

Mental Support: Integrates proven mental health tools (VR, Circadian Light Systems, Mindfulness Apps) into one adaptive system.

Insight: Provides direct, invaluable insight into an astronaut's physical and mental health for both the user and ground stations.

Customer Relationships

What type of relationship is established?

Adaptive and Personalised: The system is user-centric, adapting resistance training and mental support based on real-time movement and sensor data feedback loops.

Channels

How do we deliver the solution?

Delivery via the Halo Suite a professional product line-up consisting of Halo P (Physical, Exoskeleton), Halo M (Mental, Personalised Tool), and the central application where everything converges.

Customer Segments

Who are we creating value for?

Primarily the commercial spaceflight industry, where there is a clear market gap for integrated well-being systems. Also targets astronauts who are currently affected by severe physical and mental mission risks.

Cost Structure What are the most important costs?

would include hardware development (exoskeleton, custom PCBs), software development, and ongoing research.

Revenue Streams How do we make money?

B2B SAAS and hardware AAS

Turn ideas into revenue with Strategyzer's innovation programs

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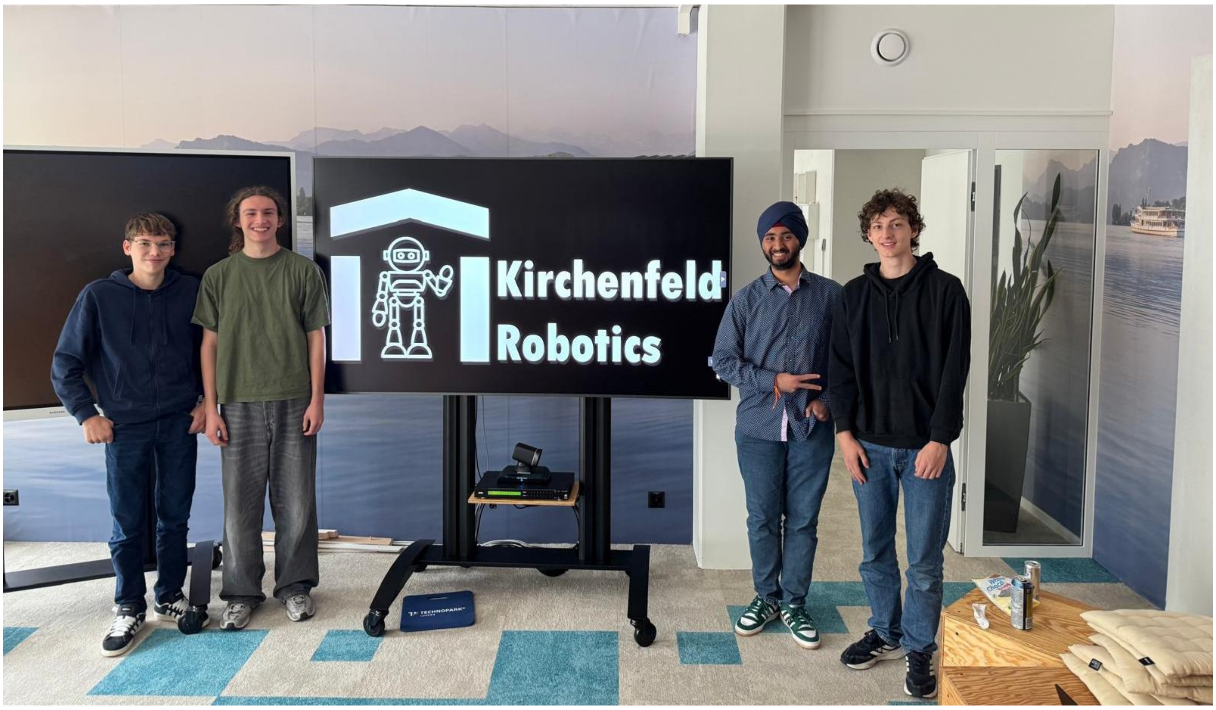
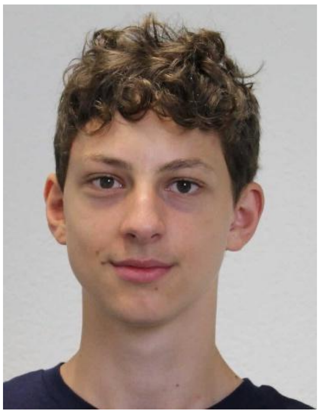
About us and Teamwork



Our Team:)

Kirchenfeldrobotics, is a team of students at the Gymnasium Kirchenfeld.

Initial Team:

David Bänzinger Valéry Piot Jakob Gutersohn

Joined during Hackathon:

Bhupinder Singh

Bhupinder's team left the hackathon early, which meant he was suddenly on his own, so we welcomed him into our team.

For organization, we used Notion and Figma, which allowed us to collaborate in real time. Jakob took the lead and helped distribute tasks across the team. It was important to us that everyone felt included, no matter their background or skill level, and that everyone enjoyed what they were working on. We usually brainstormed together on the big screens provided, then split up the tasks. Throughout the competition, we had a great time working as a team! We also want to thank the organizers of this event we had a fantastic time! The atmosphere, the support, and the energy were amazing. We're looking forward to seeing you again next year!

Sources

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