DESIGN FOR BVA

IED × BEBE ViO ACADEMY

PROJECT N.1

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PRODUCT DESIGN
TECHNO BODIES FOR EQUAL FUTURE
IED MILAN

IN MOTION
IN POWER

This project explores a new approach to **Paralympic fencing** by introducing a semi-mobile seating system designed to support learning, mobility, and engagement. Through controlled oscillation and ergonomic design, we aim to **empower children with disabilities** to explore fencing in a more natural, playful, and dynamic way.

SPORT SETUP
& CORE PRINCIPLES

In professional wheelchair fencing, athletes compete in a seated position with their wheelchairs fixed to a **metallic frame** on the piste. The sport follows the same weapons and scoring rules as Olympic fencing, but with modified posture and mobility: only **upper body movement** is allowed. Athletes rely on **trunk control**, arm extension, and precision to attack or defend.

The **distance between fencers** is determined by arm reach and remains fixed. The seating system ensures maximum stability through clamps and anchoring mechanisms. Protective gear is identical to standard fencing: **mask**, **jacket**, **glove**, and **electric scoring vest**. The discipline emphasizes timing, control, and tactical awareness, all within a static lower-body setup.

LIMITATIONS
& CURRENT INNOVATIONS

Despite advances in wheelchair design and protective gear, the rigid fencing platform has remained largely unchanged. This has led to growing interest in making the sport more dynamic, inclusive, and adaptable, especially in educational settings like the Bebe Vio Academy.

Current discussions in adaptive sport design emphasize freedom of movement, interactivity, and playfulness for children and beginners, yet no widely adopted solution has overcome the mechanical limits of the traditional setup, revealing a clear space for innovation.

PROJECT
IDEA

This project introduces a **redesigned version of wheelchair fencing** for children at the Bebe Vio Academy, addressing the rigidity of the traditional setup.

Our proposal features a central pivot system for the seating, enabling c**ontrolled multidirectional movement.** This allows beginners to explore key fencing actions like **leaning**, **dodging**, and **weight shifting** in a more intuitive and engaging way, while maintaining safety and stability.

By enhancing freedom of movement, the system promotes physical **development**, **improves spatial awareness**, and **strengthens the emotional connection with the sport.**

DESIGN CRITERIA

DESIGN GOALS

Our primary objective is to create a **seating system** and **gameplay experience** that serves as a **propedeutic tool** for young aspiring wheelchair fencers. The design must support learning, safety, and engagement through movement and adaptability.

DESIGN CRITERIA

INCREASE RANGE OF MOTION

Enable controlled upper-body movement (e.g. leaning, dodging) through a semi-mobile seat

SUPPORT PHYSICAL DEVELOPMENT

Promote balance, coordination, and postural control in a playful, sport-specific way

FOSTER ENGAGEMENT

Encourage experimentation and confidence-building through movement and discovery

ENSURE SAFETY

Integrate mechanical limiters or dampers to guide motion safely and prevent tipping

ENABLE ADAPTABILITY

Adjustable to different body sizes, abilities, and learning stages

REFLECT BEBE VIO ACADEMY VALUES

Promote inclusivity, fun, and empowerment from the start

CONTROLLED, MULTIDIRECTIONAL OSCILLATION

LIGHTWEIGHT AND ROBUST MATERIALS for regular use

COMPATIBLE WITH STANDARD FENCING GEAR and safety norms

PORTABLE AND EASY TO ASSEMBLE for flexible use

VISUALLY ENGAGING for kids and young athletes

DESIGN GOALS

CLASSIFICATION SYSTEM

Athletes are divided into categories based on their level of physical ability:

CATEGORY A

Athletes with good balance and full trunk movement.

CATEGORY B

Athletes with impaired trunk control or balance.

CATEGORY C

Athletes with more severe impairments (not currently included in the Paralympic program).

THE CONCEPTS

CONCEPT 1

HELIX

This concept proposes a simplified dynamic seat for early wheelchair fencing training. It replaces the fixed setup with a **central shaft** and **spring mechanism** that allows **controlled multi-directional tilt.** As the user leans, the spring provides resistance and guides the seat back to neutral, promoting balance, postural awareness, and playful movement.The design enhances **trunk control**, **spatial perception**, and **vestibular stimulation**, making the sport more intuitive and engaging for young athletes.

TECHNICAL
OVERVIEW

CORE COMPONENTS

Central shaft

Rigid tube connecting the seat to the base; ensures structural support and transfers body motion

Elastic element

A mechanical spring (torsion or compression) placed at the base or surrounding the shaft, enabling controlled tilt and automatic return

Adjustable seat

Mounted on top of the shaft; height and padding customizable to fit various user profiles

User restraints

Soft straps or lateral supports to maintain stability and postural alignment

Support base

Wide and stable anchoring platform, ensuring safety during dynamic movements

FUNCTIONAL
STUDY

In the design of the dynamic seating system based on a central shaft and spring, specific guidelines have been established to define the maximum safe tilt angles. These constraints are essential to balance **freedom of movement** with **stability** and are particularly important for children with different levels of trunk control.

FUNCTIONAL
STUDY

DIRECTION	SUGGESTED LIMIT	RATIONALE
Forward tilt	10°- 12°	Supports fencing-like leaning while minimizing the risk of falling forward
Backward tilt	8°- 10°	More limited due to instability when leaning backward
Side-to-side	8°- 10° each side	Encourages lateral engagement and trunk control without compromising safety

For users with reduced trunk control (e.g. Category B or C), these angles should be adjustable and can be reduced to 6°- 8° depending on their specific needs.

LIMITING METHODS

To physically control the range of movement, the following mechanisms are proposed:

Spring calibration: stiffness selected to limit the range of compression within safe tilt boundaries

Progressive bumpers: elastomer or rubber dampers that resist and slow tilt as it nears the maximum angle

CONCEPT 2

AXIS

This project introduces a mechanical tilting seat designed to support young wheelchair athletes during fencing training. The system is based on a spherical joint mounted to the platform, allowing **controlled multi-directional tilt**. A **central vertical tube** connects the joint to the seat, which is surrounded by **four compression springs**. These springs provide resistance and a self-centering return, encouraging active posture control while maintaining safety. The seat is adjustable and equipped with **support straps**, making it suitable for various body types and ability levels. The setup promotes **movement-based learning**, balance development, and playful engagement with the sport.

TECHNICAL
OVERVIEW

CORE COMPONENTS

Spherical joint (cardanic mount) fixed to the platform, enabling multidirectional tilt (X/Y axes)

Vertical central tube connecting the joint to the seat structure

Four **compression springs** (one per direction: front, back, left, right) with partial articulation

Spring anchors: single-axis joints connecting springs to the platform and seat tube

Limiters: physical stops or preset angles to restrict maximum tilt

FUNCTIONAL
STUDY

In the design of the dynamic seating system, specific guidelines have been hypothesized to define the **maximum tilt angles** allowed during use. These limits are intended to ensure **functional freedom of movement** while maintaining **user safety** and **postural stability**, especially for children with varying degrees of trunk control.

FUNCTIONAL
STUDY

DIRECTION	SUGGESTED LIMIT	RATIONALE
Forward tilt	10°- 12°	Allows fencing-inspired forward leaning while avoiding the risk of falling forward.
Backward tilt	8°- 10°	Slightly more restricted due to greater risk of instability when tilting backward.
Side-to-side	8°- 10° each side	Encourages trunk activation and lateral control without compromising safety.

For users with reduced trunk control (e.g. Category B or C), these angles should be adjustable and possibly reduced (e.g. 6°-8°), depending on individual needs.

LIMITING METHODS

To physically control the range of movement, the following mechanisms are proposed:

Integrated mechanical stops within the spherical joint or the base structure to prevent over-tilt.

Progressive spring resistance, calibrated so that the maximum compression coincides with the target tilt limit.

Elastomeric bumpers or damping materials to provide gradual deceleration before reaching the limit, ensuring smooth transitions.

COMPARATIVE
TABLE

CATEGORY	HELIX	AXIS
MOTION CONTROL	Centralized tilt via a single spring; axial movement with smooth return to neutral	Multi-directional tilt controlled by 4 compression springs with directional feedback
STRUCTURE	Central shaft › spring at base or around shaft › adjustable seat	Spherical joint › vertical tube › adjustable seat
COMPONENTS	Central shaft, one calibrated spring, adjustable seat, user restraints	Spherical joint, 4 springs with single-axis joints, adjustable seat, straps, flat base
SAFETY CONTROL	Controlled by spring stiffness and progressive bumpers to limit tilt	Managed through calibrated spring layout and mechanical stops per direction
COMPLEXITY OF BUILD	Lower: fewer parts, easier assembly and maintenance	Higher: more components and symmetrical calibration required

FEATURE	HELIX	AXIS
TYPE OF MOVEMENT	Centralized tilt with smooth, unified return	Multidirectional with resistance per direction
MOTOR FEEDBACK	Uniform response regardless of direction	Direction-specific (left ≠ right ≠ front ≠ back)
LEARNING CURVE	Lower - encourages safe, intuitive exploration	Higher - supports differentiated, intentional movement
SKILL FOCUS	General balance, posture, early trunk activation	Trunk symmetry, spatial control, gesture precision
BEST FOR	Introductory stage; first contact with fencing-related movement	Mid-to-advanced learning; pre-sport preparation

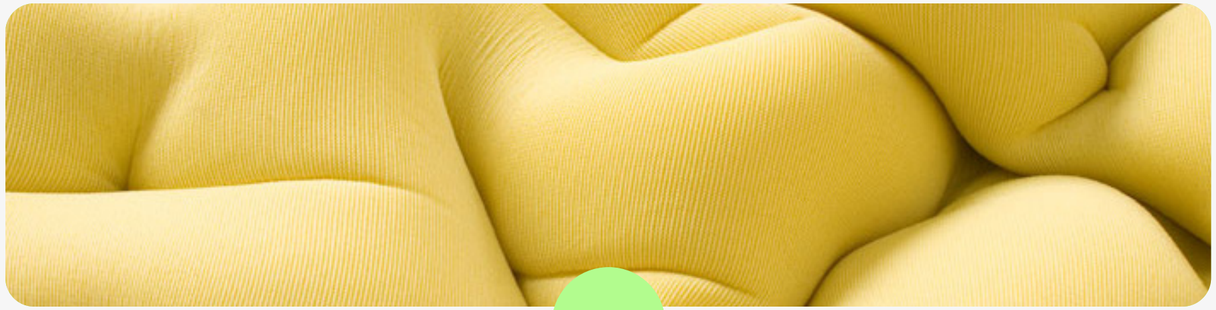
PROJECTS
ANALYSIS

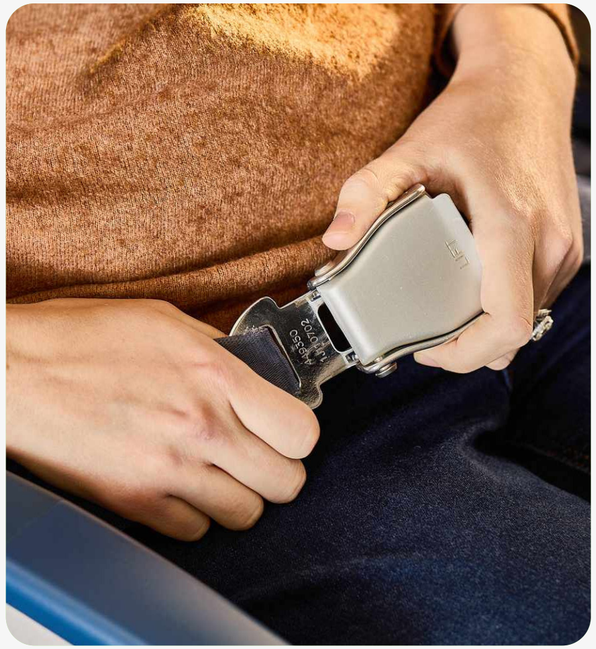
PARAMETER	HELIX	AXIS
MOVEMENT CONTROL QUALITY		
EASE OF ASSEMBLY		
STRUCTURAL RIGIDITY		
OVERALL COST		
DIRECTIONAL RESPONSIVNESS		
EASE OF SETUP		
MAINTENANCE AND		

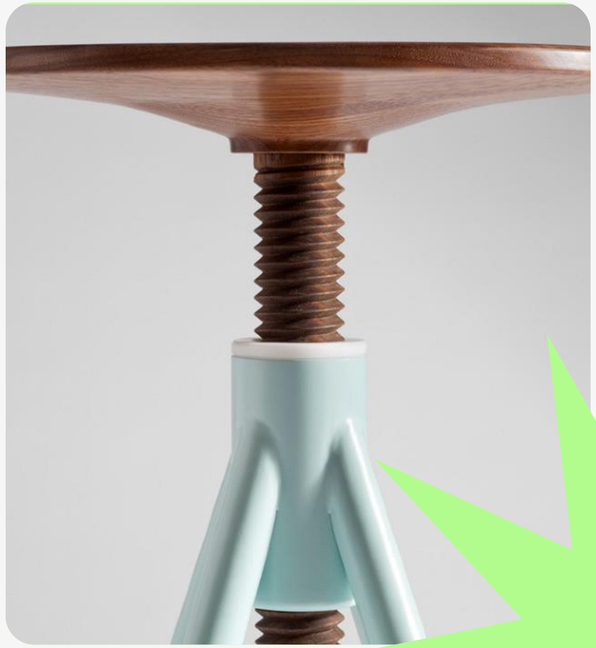
HELIX	AXIS
27	24

In terms of accessibility, simplicity, and ease of use, Helix offers a more balanced solution for early-stage learning. Axis, on the other hand, excels in movement quality and advanced sport-specific preparation, but requires greater technical setup and maintenance. For this reason, **Helix is better suited for children, adolescents, and users with more complex physical disabilities**,


HELIX



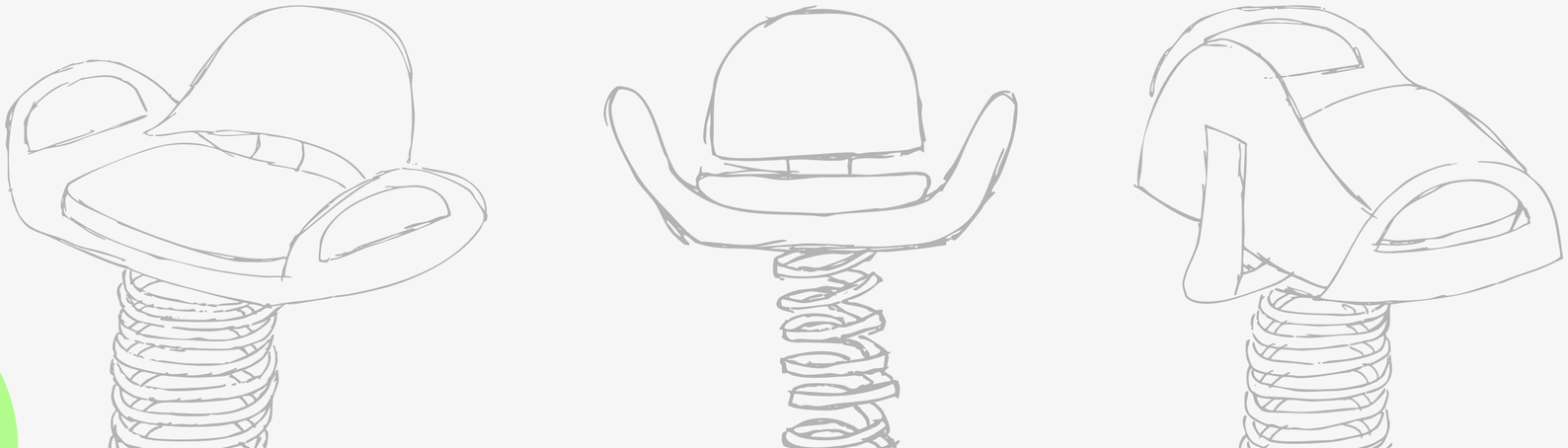




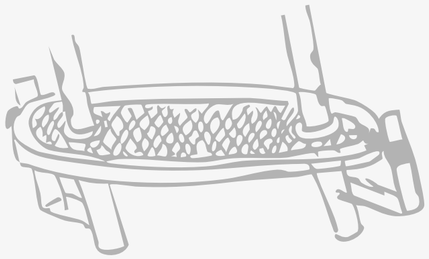
MORPHOLOGICAL
STUDY

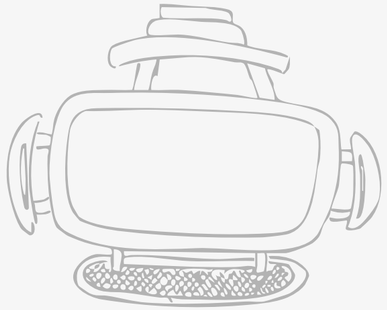
The seat´s form is designed to mediate between **containment** and **freedom.** It features a gently concave sitting surface that promotes pelvic stability, while the rounded lateral edges support side-to-side balance without restricting movement. The front edge is open and lowered, allowing unobstructed leg motion during forward tilt.

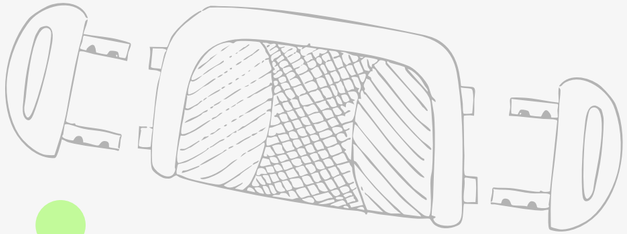
The backrest is short and curved, offering a cue for posture without limiting trunk movement. Overall, the shape remains neutral and approachable, combining soft transitions and geometric clarity to evoke both play and structure.

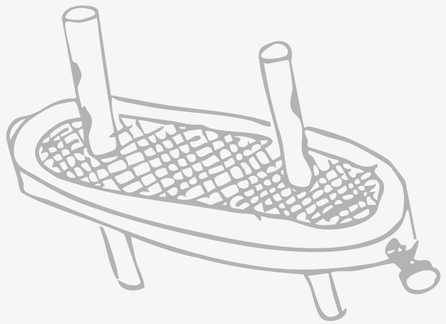


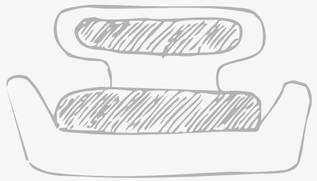
INITIAL
SKETCHES

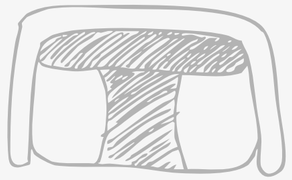


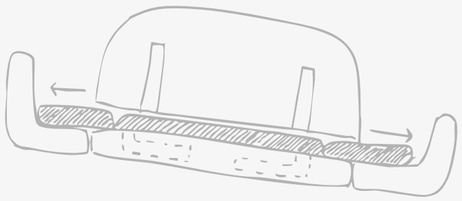


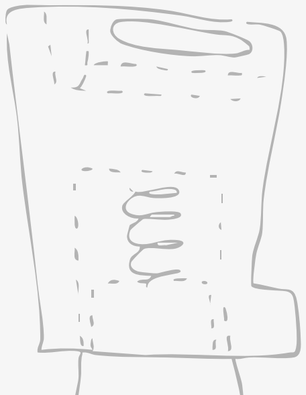


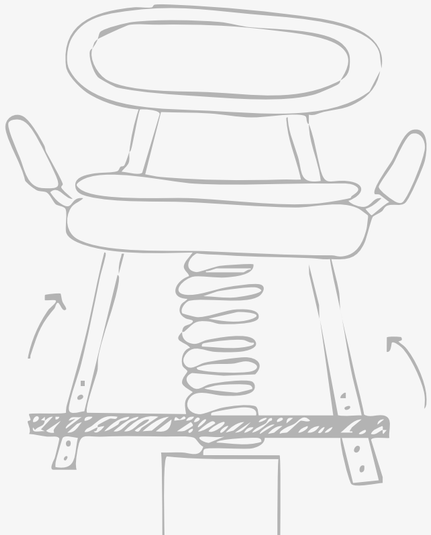


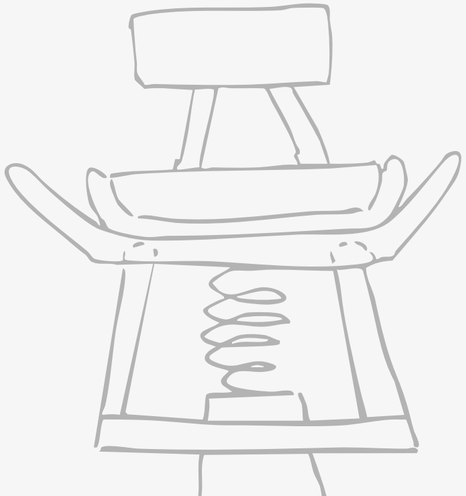


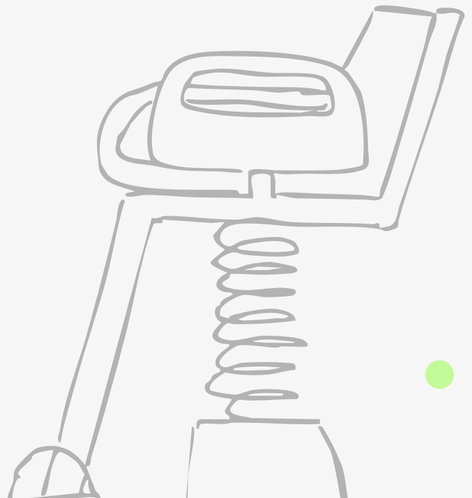






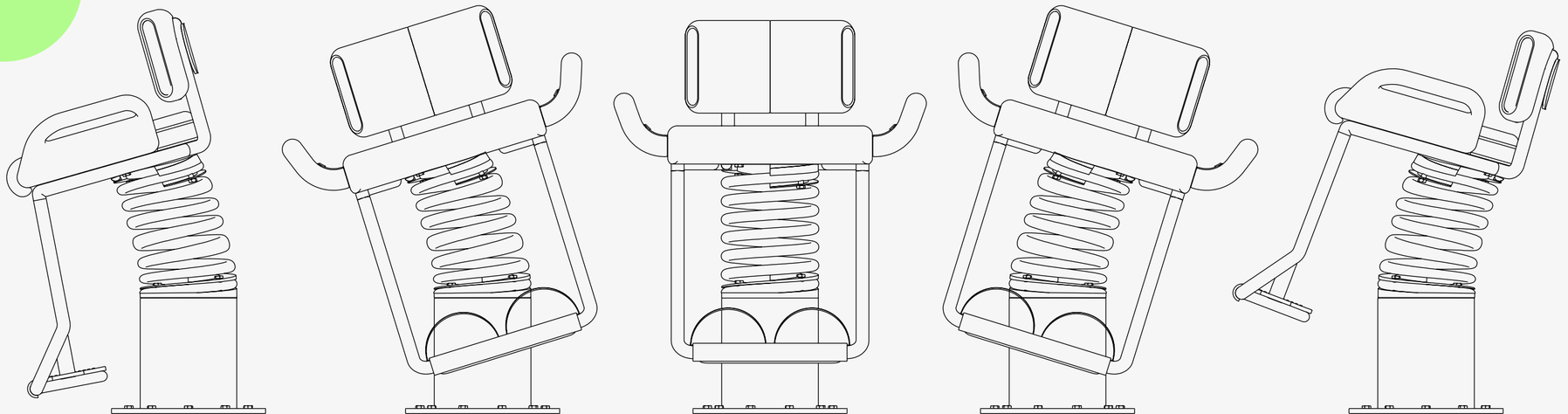






SEATING
LOGIC

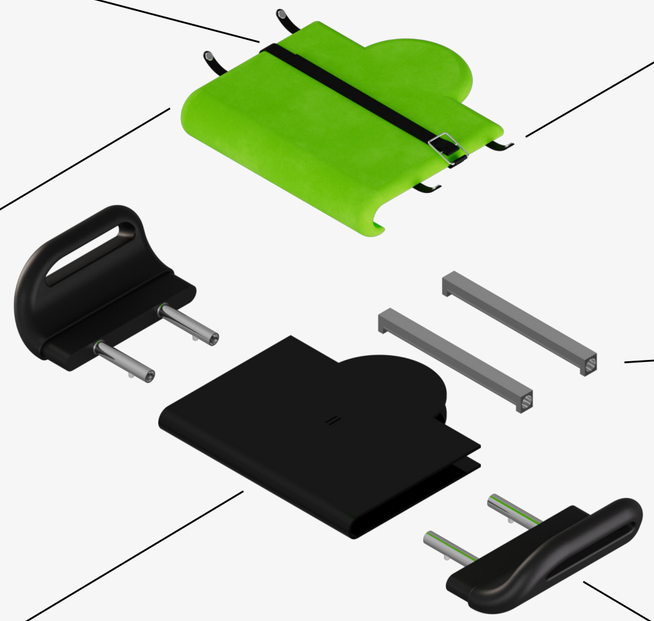
Helix enables passive, user-driven tilting across all directions through a central spring-loaded shaft. The seat responds proportionally to upper-body movements, offering a dynamic but safe range of motion. Tilting **forward is allowed up to 10–12°**, mimicking fencing gestures while avoiding the risk of falling. **Backward** tilt is slightly more limited, **at 8–10°**, to reduce instability. Lateral tilting reaches up to **8–10° per side**, promoting active trunk engagement and spatial awareness.



COMPONENTS
& TECHNOLOGY

ADJUSTABLE BELT

TENSION STRAPS
Nylon webbing under the cushion, keeps surface taut and adapts to width changes.



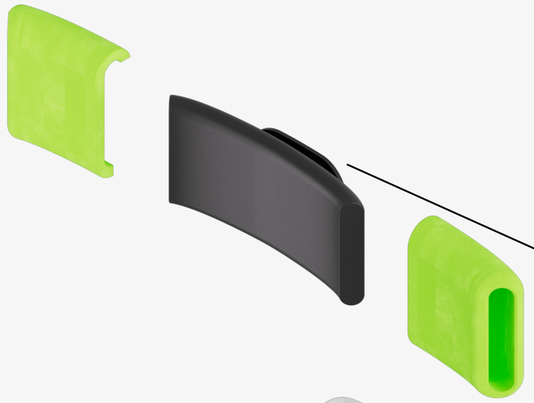
SEAT CUSHION
PU foam with stretch slits, elastic fabric, expands with armrest width.

TELESCOPIC FEMALE RAILS

SEAT PLATE
5 mm aluminium sheet, cut and bent for structure, hides rail system under cushion.

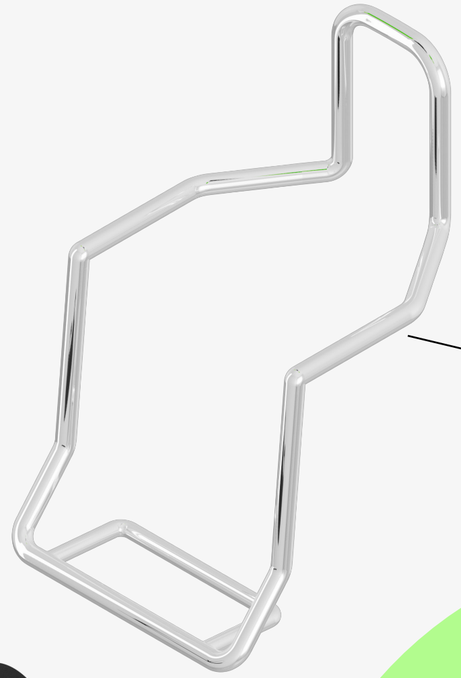
ARMRESTS
Rigid PU foam moulded over tubular structure for safe, contact surface.

BACKREST PADDING
PU foam with textile cover, follows the shell shape, non-restrictive, divided in two.



BACKREST SHELL
Roto-moulded HDPE, curved for lumbar support, interfaces with rear tube.

FOOT BELT

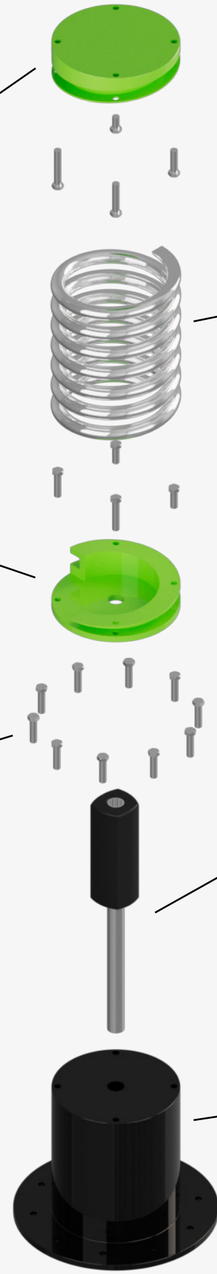


TUBULAR STRUCTURE
Bent steel tube, welded under the seat and bolted behind the shell for full support.

FOOTREST
HDPE platform, supports feet for increased postural stability.

MOUNTING PLATES
Standard bolted steel interfaces between shaft, spring, and seat base.

THREADED BOLTS



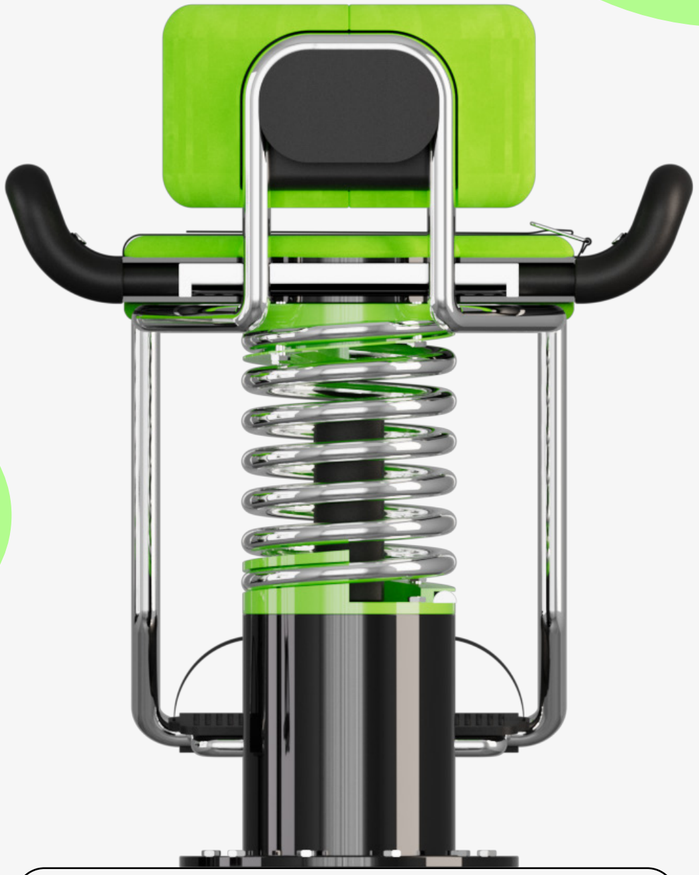
SPRING UNIT
Mechanical torsion spring, enables passive return to center.

TILT LIMITER
Steel tube with a silicon cover, limits the tilt angle of the system.

BASE FRAME
Steel central pivot, connects platform and seat, allows multidirectional tilt.

FRONT VIEW

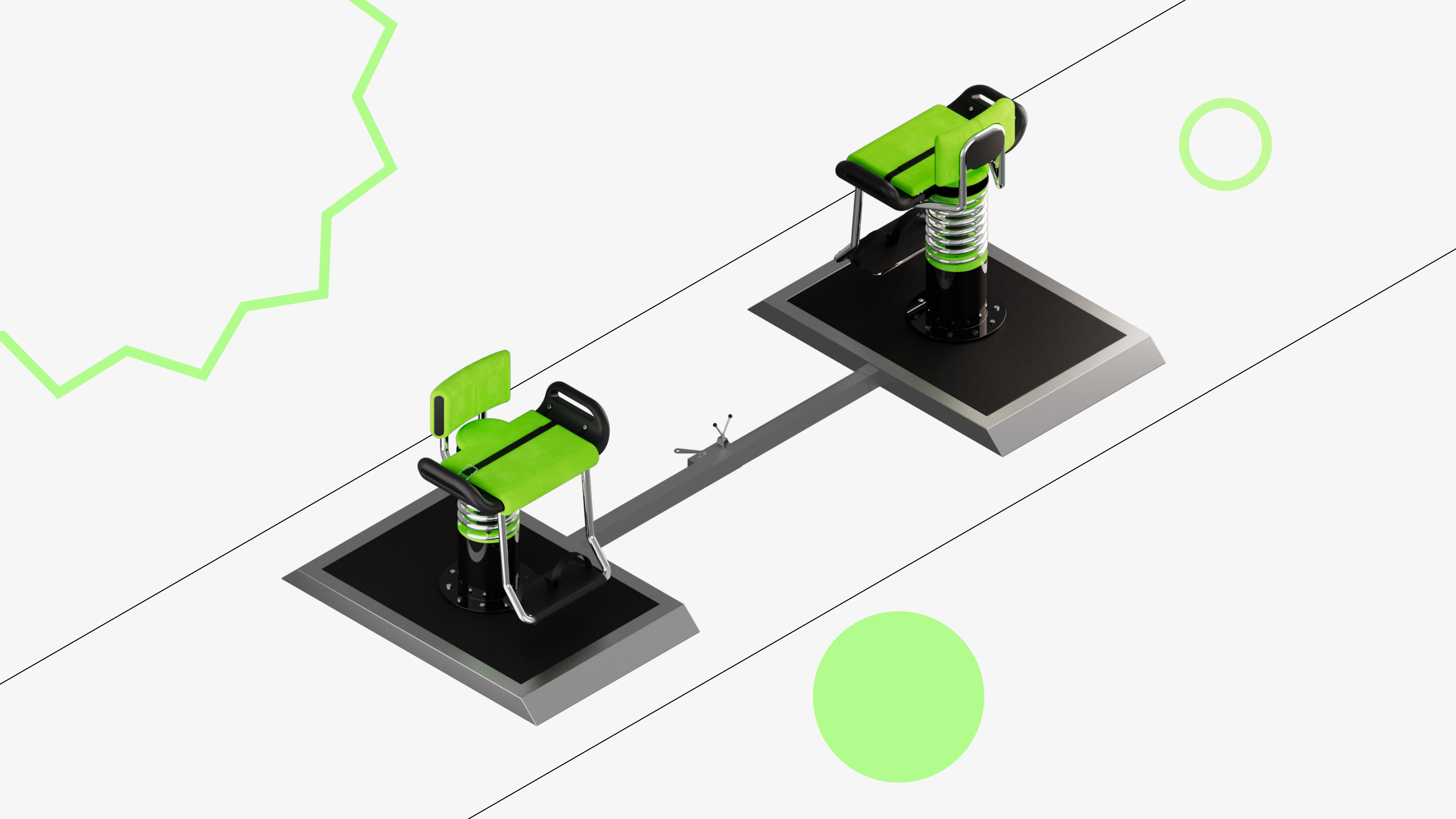
SIDE VIEW

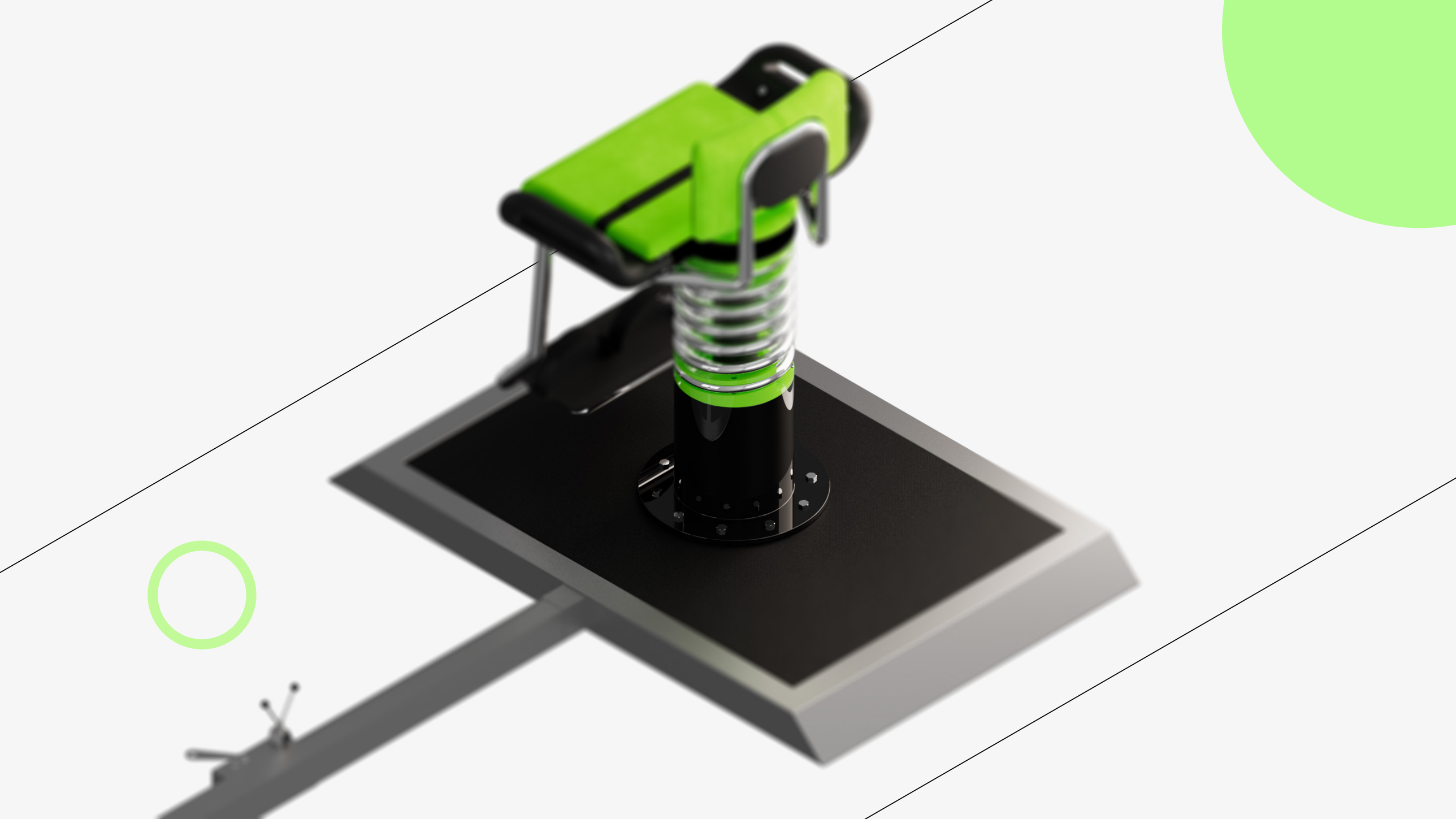


REAR VIEW

CLOSED ARMRESTS

EXTENDED ARMRESTS

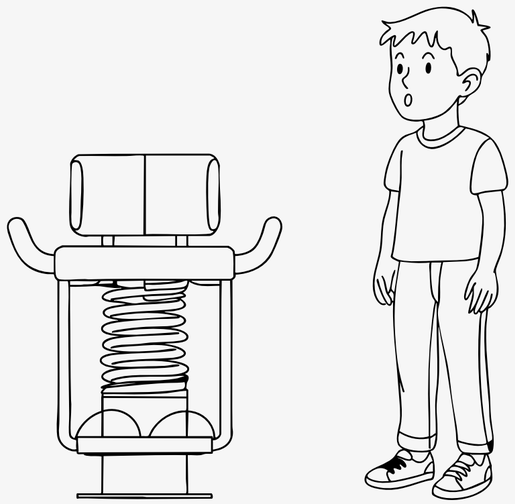




CONTEXT
OF USE

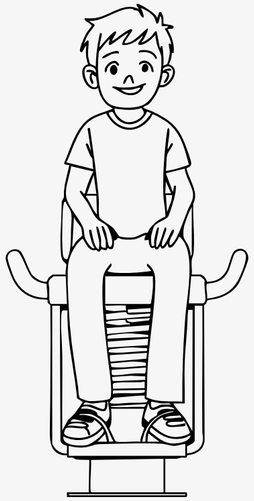
ASPECT	DETAILS
WHERE	Indoor training spaces at BVA (gyms, modular platforms, practice rooms)
WHEN	Warm-ups, movement workshops, early fencing sessions
WHO	Children assisted by coaches or trained staff
HOW	Used freely under supervision, no technical setup required
WHY	To promote motor exploration, balance training, and playful engagement
HOW LONG	Short to medium sessions (10-20 minutes) within broader training routines

USER JOURNEY



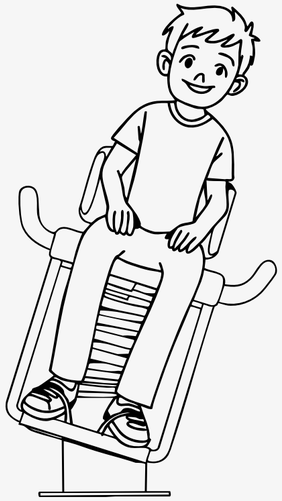
1. APPROACH

• The child notices the seat and approaches with curiosity
• Friendly shapes and soft colors reduce hesitation and spark interaction



2. SEATING

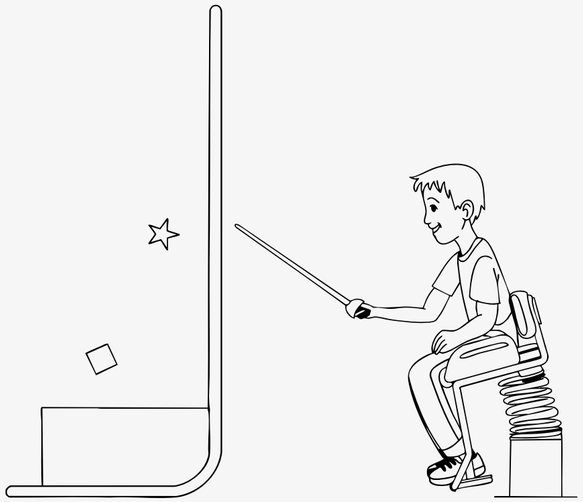
• The child approaches and sits down independently, feeling safe
• The seat´s open front and soft edges offer a sense of safety and inclusion



3. EXPLORATION

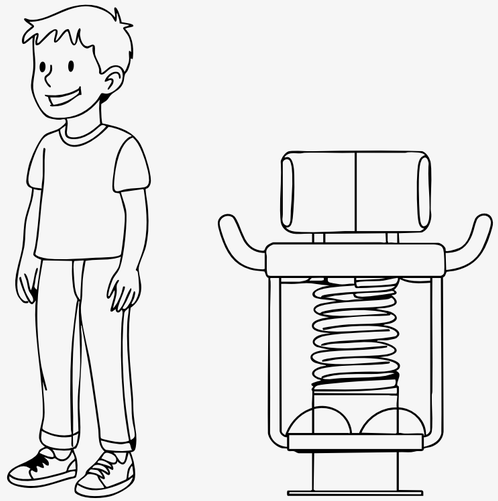
• The child instinctively begins shifting weight playfully
• Gentle tilting and smooth return help build body awareness and trust

USER JOURNEY



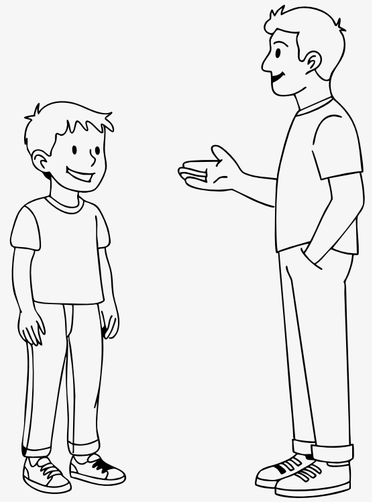
4. **PLAY**

• The child follows prompts (e.g. “lean left”) during mini-games
• Directional feedback promotes coordination and trunk controll



5. **COOL DOWN**

• After a short session, the child gets off independently or with assistance
• The dismount is easy and gives a senseof autonomy and progress



6. **RETURN**

• The child is likely to return again voluntarily and confidently
• The experience is playful, inviting, and leaves a positive emotional trace

THE MINIGAMES

To complement the dynamic seating system, a set of playful minigames has been designed to help children develop essential fencing-related skills in a safe, engaging, and inclusive way.

These games focus on improving **balance**, **reaction time**, **coordination**, and **spatial awareness**, using the seat's tilting mechanism as the core interaction tool. Whether played alone or with a partner, each activity transforms physical training into an accessible and enjoyable learning experience.

TARGET POP

A precision-based minigame where the child tilts the seat to “hit” colorful targets positioned around them

OBJECTIVE

To improve postural control, hand-eye coordination, and directional awareness through focused, playful movements

HOW IT WORKS

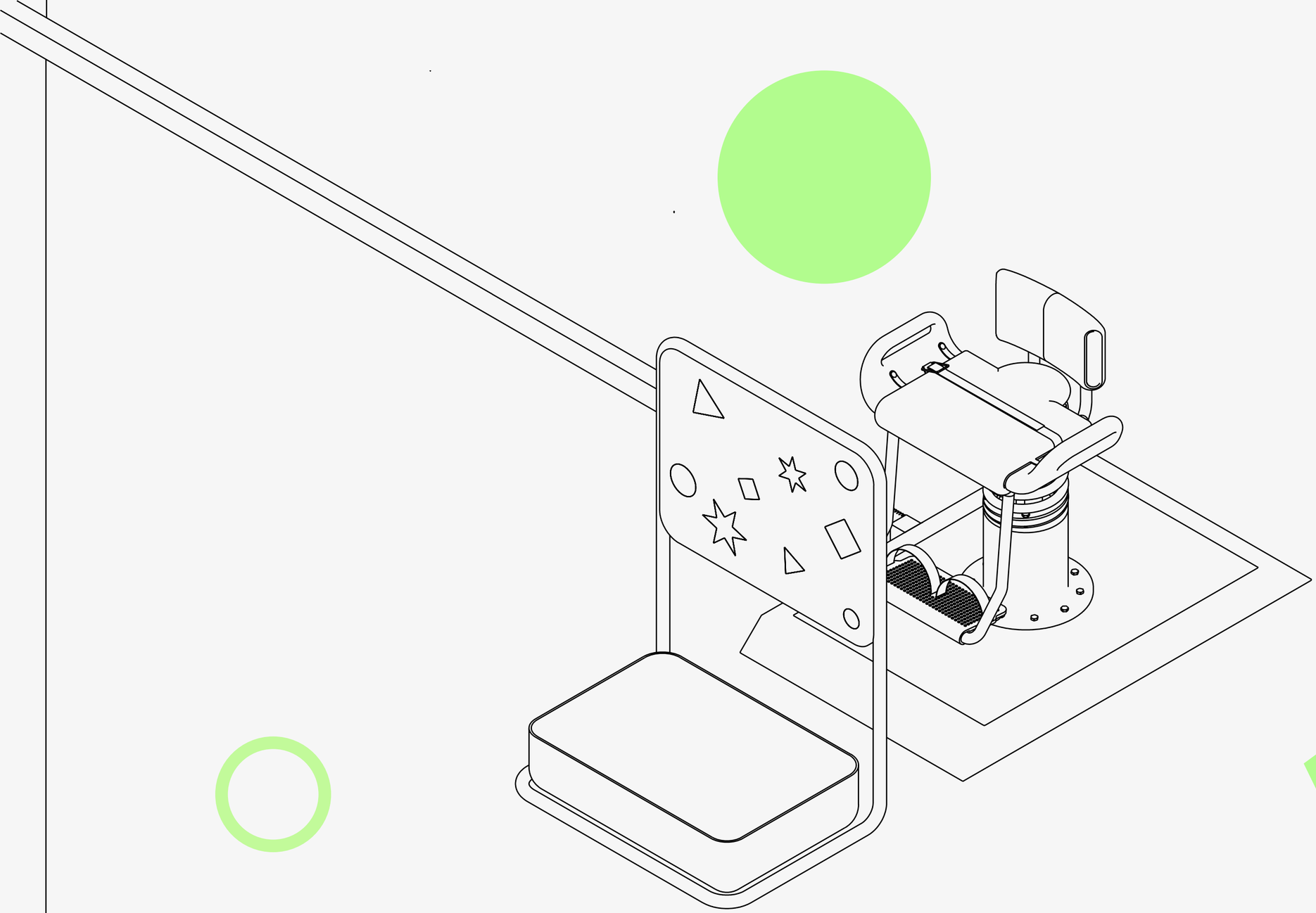
1. Static or movable targets are placed at various angles around the child

2. The participant tilts the dynamic seat to align a pointer (or extend an arm/foam weapon) toward each target

3. Each successful hit earns a point. The game can be time-based or played in rounds

VARIATIONS

- Increase difficulty by reducing target size or adding motion
- Introduce color-coded targets that must be hit in a specific sequence



REACTION
RACE

A fast-paced game of reflexes where the child responds to random visual or audio signals by leaning in the indicated direction

OBJECTIVE

To develop faster reaction times and improve sensory-motor coordination

HOW IT WORKS

1. Visual (lights) or auditory (sounds) cues indicate which direction to lean

2. The participant must tilt the seat accordingly, as quickly and accurately as possible

3. Reaction time is tracked, and quicker responses earn higher scores

VARIATIONS

•Add memory-based challenges (e.g. follow a sequence of directions)

•Create a competitive version for two players racing side by side