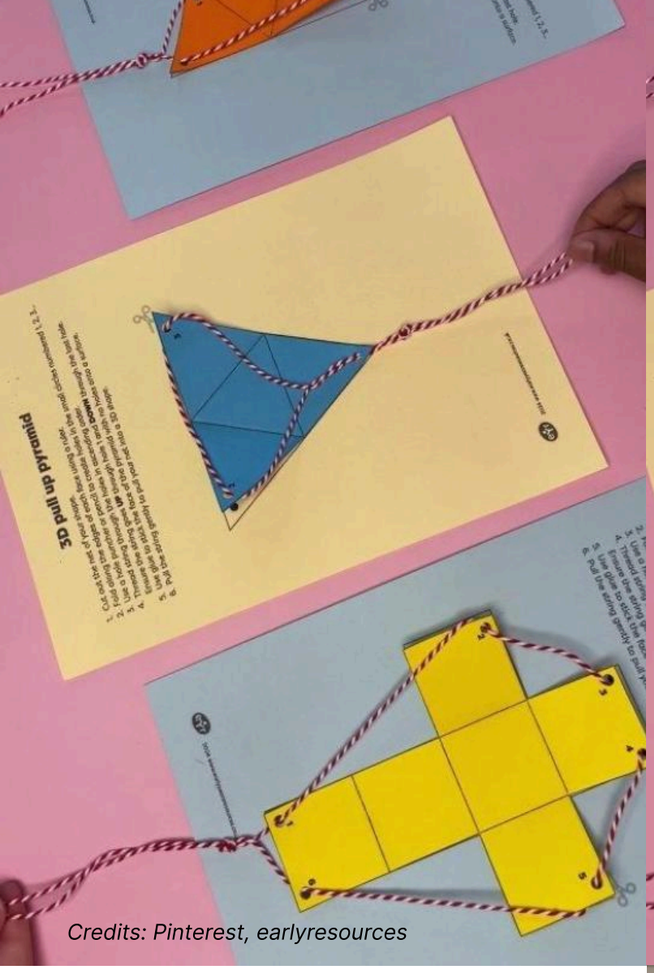
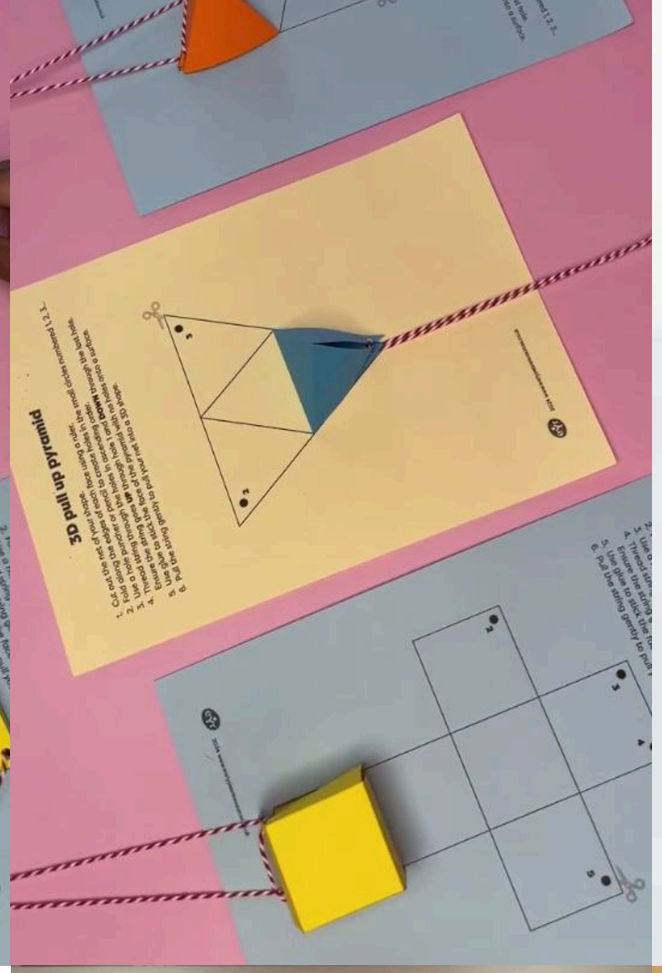
CUBIC RHYTHMS

Cubic Rhythms combines marble runs and puzzle games into a competitive, hands-on experience where players navigate marbles upward through a maze built from folding cube nets. Speed, skill, and strategy are key to victory. Using no electronics, batteries, or motors, the game relies on string mechanisms, gravity, and gameplay to create a challenging yet playful experience.



Credits: Pinterest, earlyresources

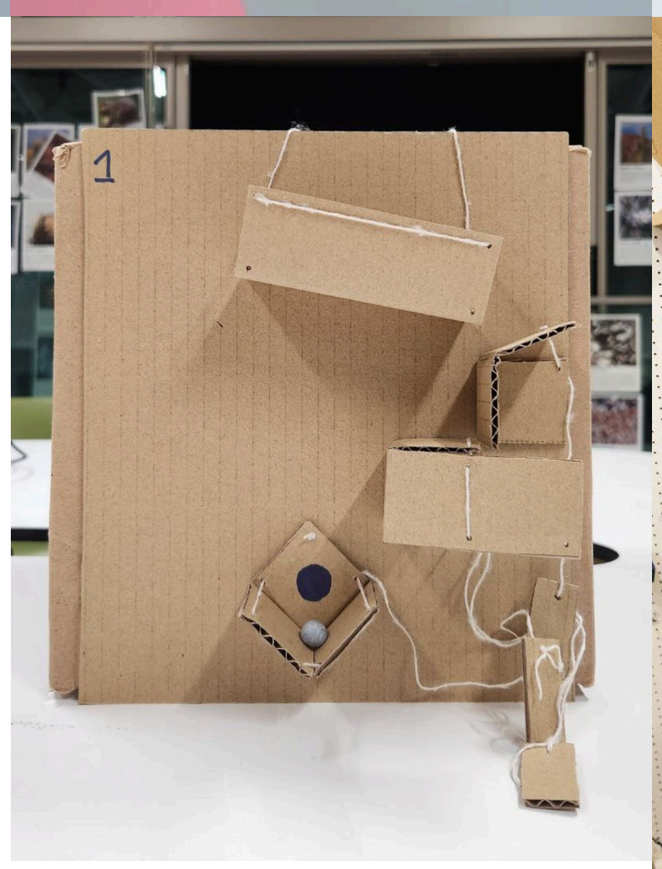


Credits: Deep Make, Infinity Trax

Pull-up Cube Nets

Our exploration began with string-actuated cube nets which are flat structures that transform into predefined three-dimensional forms with a single pull. We were drawn to the movement, which feels organic yet clearly shifts between two stable states. This reliability inspired us to use this mechanism as a means of interaction.

We saw potential to repurpose it beyond its usual educational role. By pulling a string, the folded shape can temporarily hold an object and releasing it returns the net to a flat state and releases the object. This simple action becomes a new way of transporting objects through space.



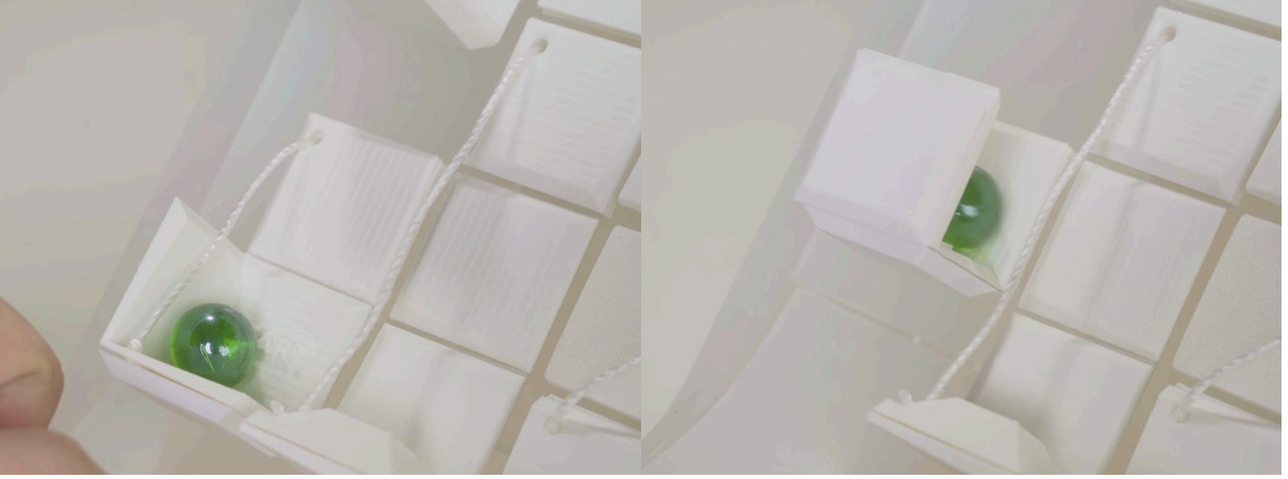
Credits: Nathan Selikoff, Giant Marble Chute

Rethinking the Marble Run

At the same time, we noticed similarities between our ideas and existing marble runs. Various mechanism move marbles along the track. However, these marble runs are often passive. The marble is released, and the player simply watches it run.

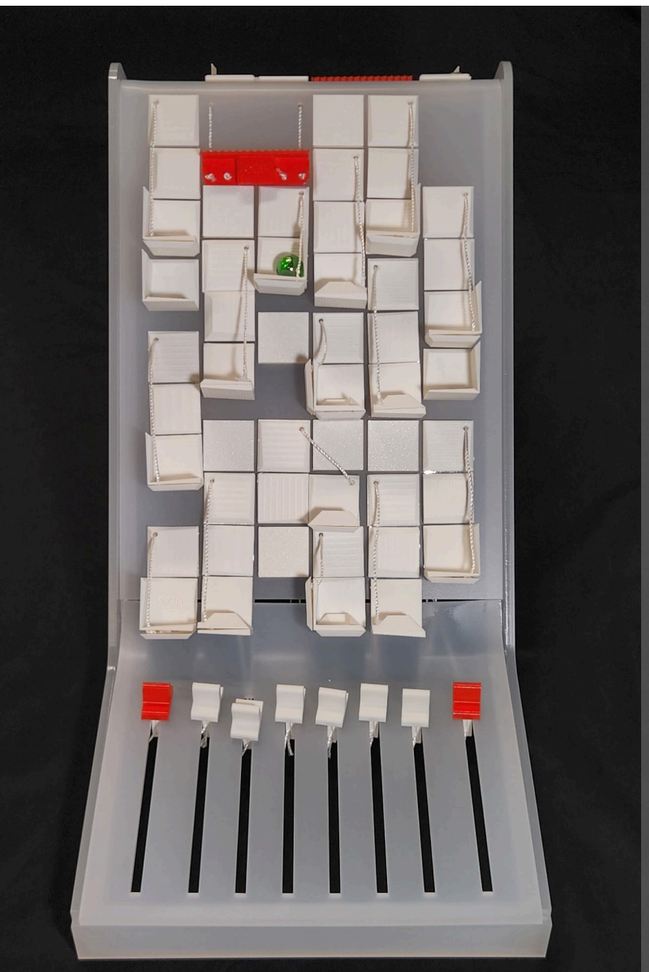
String-actuated cube nets prompted us to rethink what is possible with marble runs. What if players could interact with the marbles? What if the marble could travel upward instead of down?

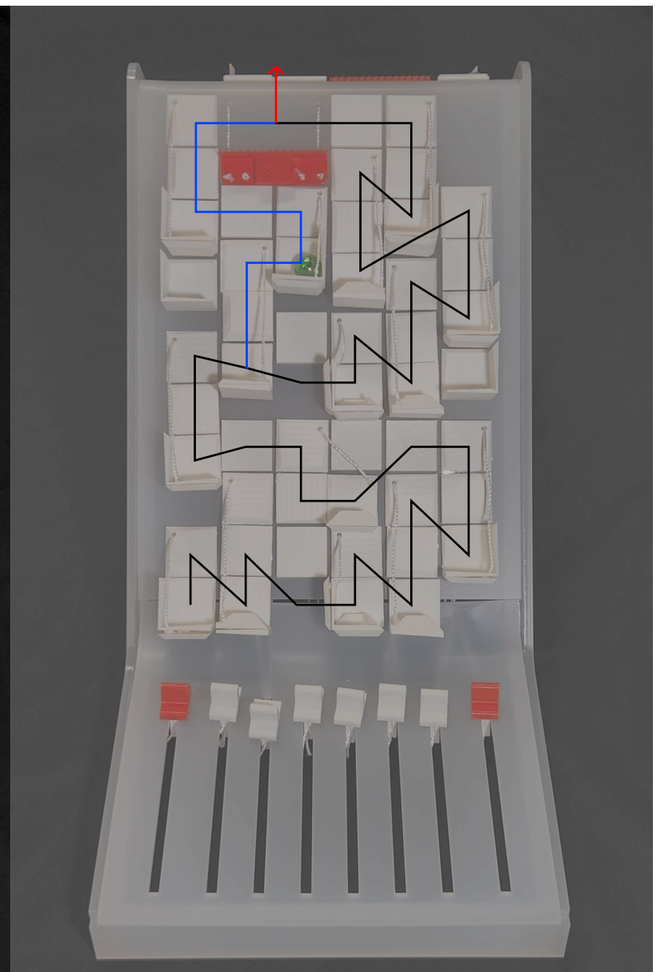
These questions became the foundation of Cubic Rhythms.



Concept Development

We combined the idea of transporting marble upwards with string-actuated cube nets mechanism to form our game. Each block is a variation of a cube net. When assembled, they create a maze-like puzzle game where each pull folds a cube, transferring the marble to the next cube. Through sequential folding and unfolding, players guide their marbles upward until the final launch, where the marble is sent across to the opponent's side.





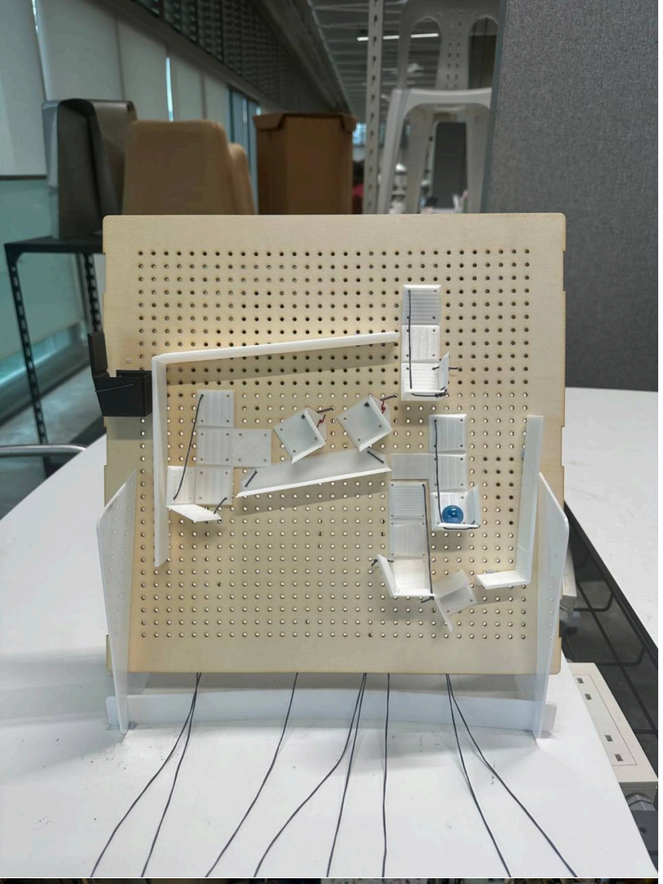
Design Process

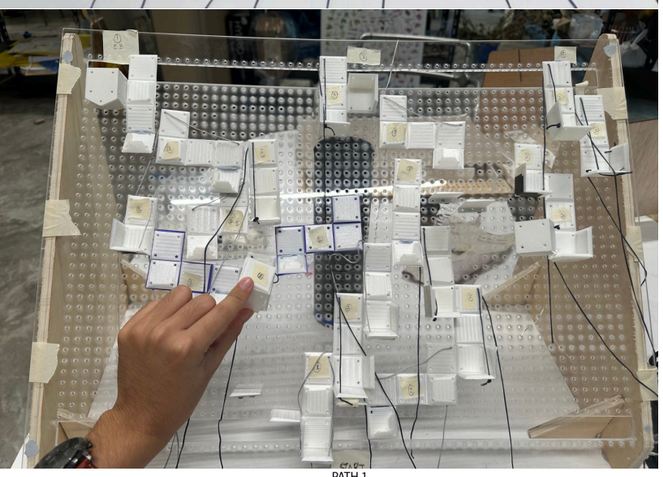
Throughout the process of designing Cubic Rhythms, we focus on three core aspects of design:

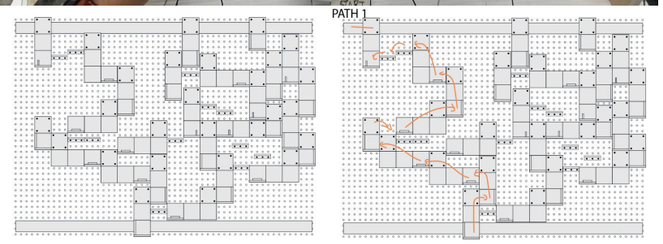
Experience Design
How can we pack as much fun and as many game elements as possible into Cubic Rhythms?

Interaction Design
How can we make playing Cubic Rhythms feel intuitive, frictionless and satisfying?

Product Design
How can we design Cubic Rhythms to look coherent and refined?







Experience Design

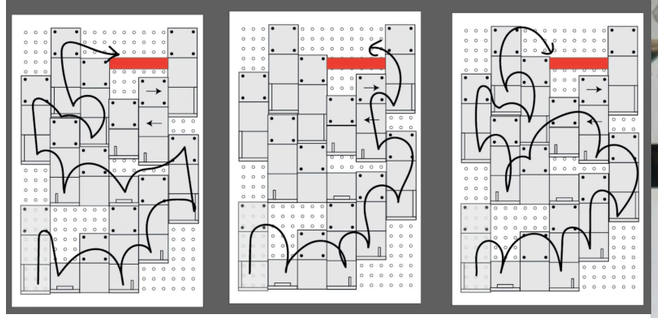
“A challenge that is neither too easy nor too hard”

Jesse Schell
The Art of Game Design

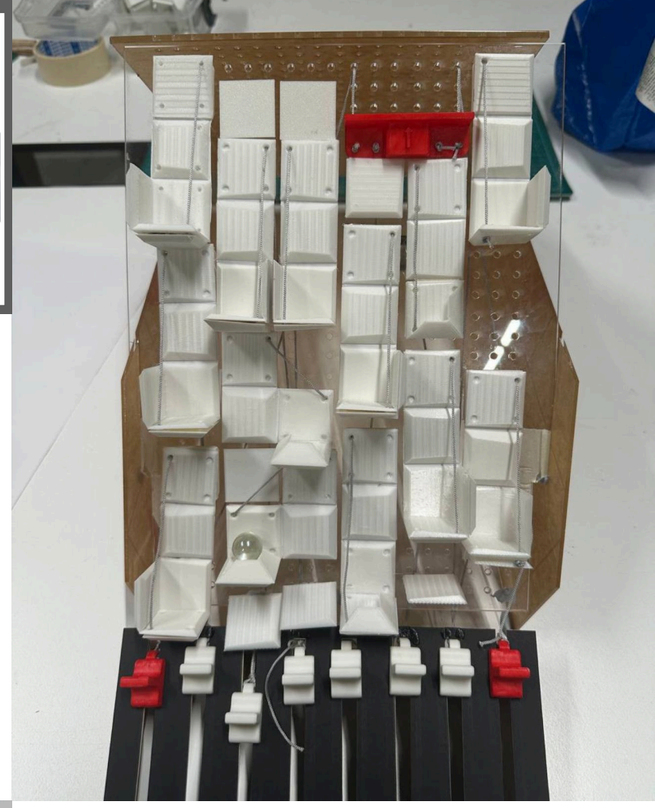
Finding the Right Challenge

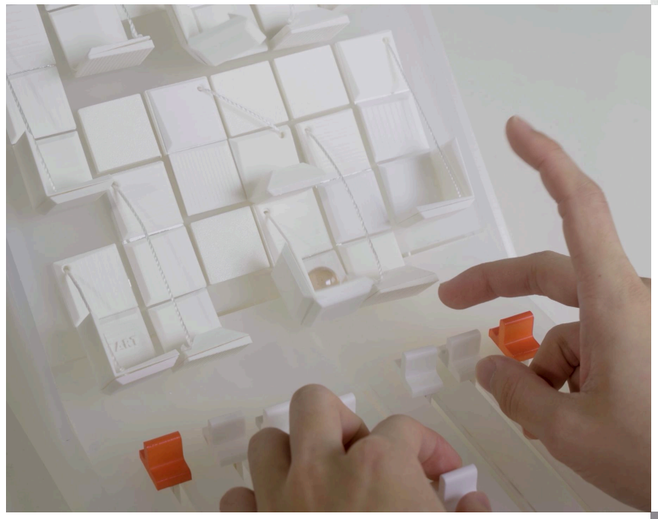
The first challenge was defining a level of difficulty that felt engaging but achievable.

Early prototypes consisted of simple paths using cubes and ramps. However, test players quickly find these paths too obvious, leaving little room for exploration or replayability. We explored increasing the complexity, adding crossing paths and enlarging the whole board. However, it reached a scale that is way too complex for anyone to solve and too frustrating to play.



We constrained ourselves to a 6 × 9 grid which forced us to be more deliberate and creative in balancing space constraint and providing enough challenges. Progressive difficulty was built into the path, helping players gradually familiarise themselves with the mechanism before encountering more complex scenarios.



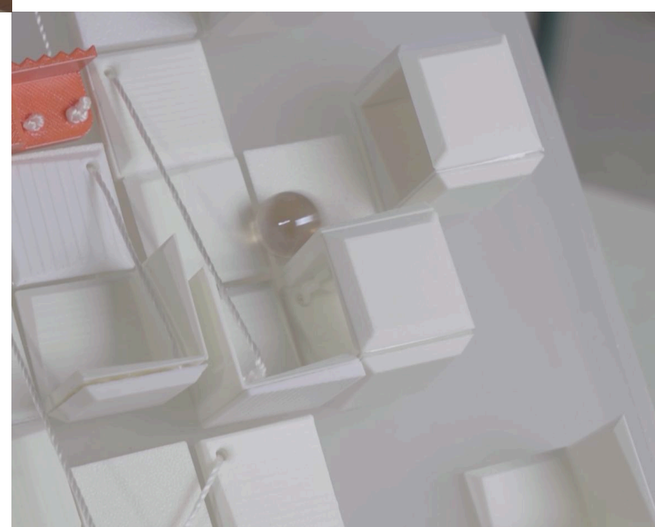


Level 1: Onboarding

Players start by learning the mechanics. Each column is controlled by a slider. Pulling it folds all cube nets in the respective column, transporting the marble upward.

Level 2: Coordination

Players must fold multiple cube nets in sequence. To progress, they must first create a temporary bridge by folding an adjacent cube, then fold the cube holding the marble. Pulling in the wrong order causes the marble to fall back, allowing another try.



Level 3: Tricks and Mastery

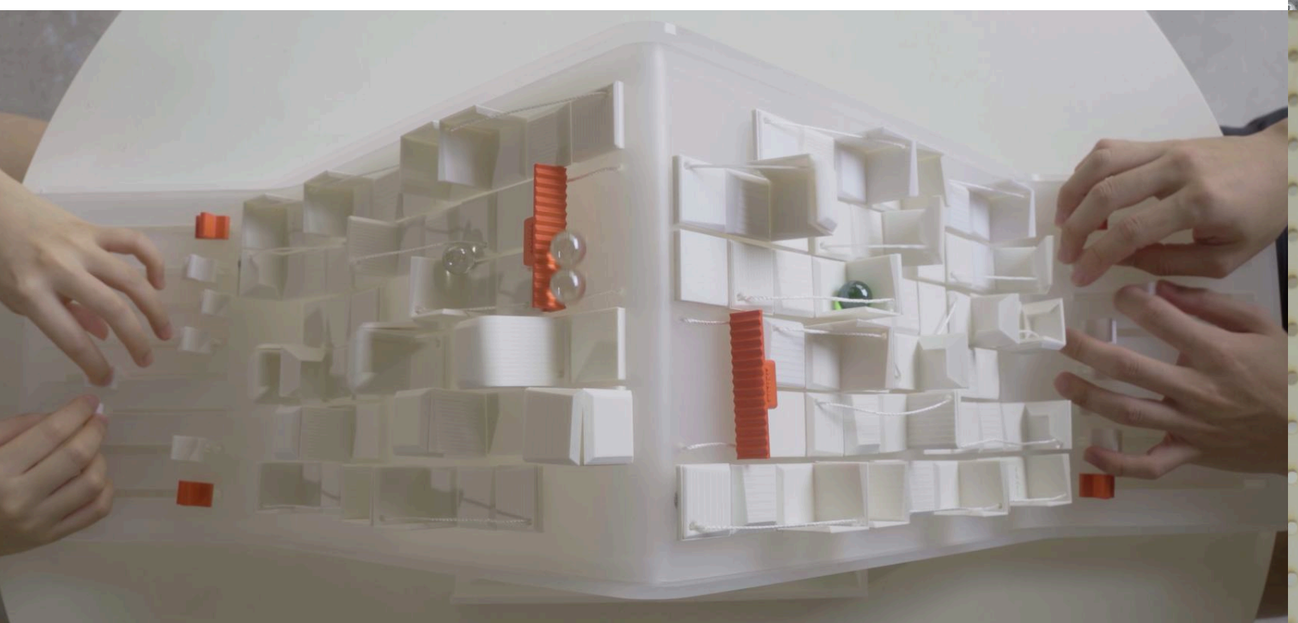
Players can continue to follow the intended path to the red ramp or discover shortcuts that require timing and precision, such as folding a cube before the marble runs to the next one or pulling harder to fling the marble forward. With the right force, players may skip multiple cubes, or fall back to the start.

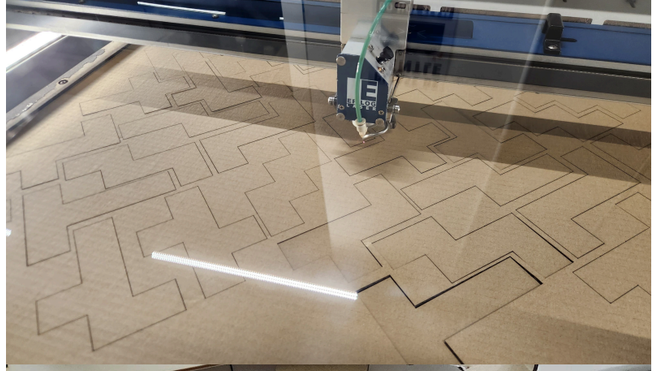
The game can be played solo, encouraging players to improve their timing by pulling various tricks.

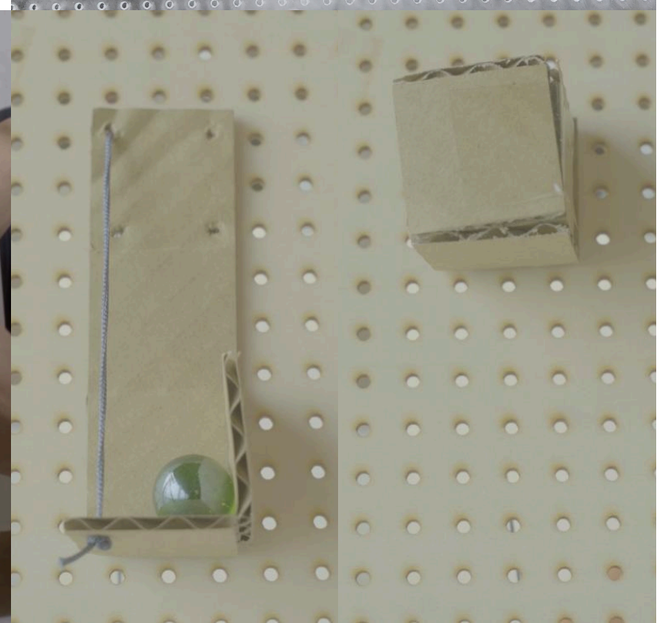
Current record: 18 seconds.

Level 4: Competition

In the competitive two-player mode, players race each other to be the first to send all their marbles to the opponent's side. While focusing on moving their own marbles upward, incoming marbles can block paths or knock marbles down, creating unpredictable obstacles and chaotic fun.







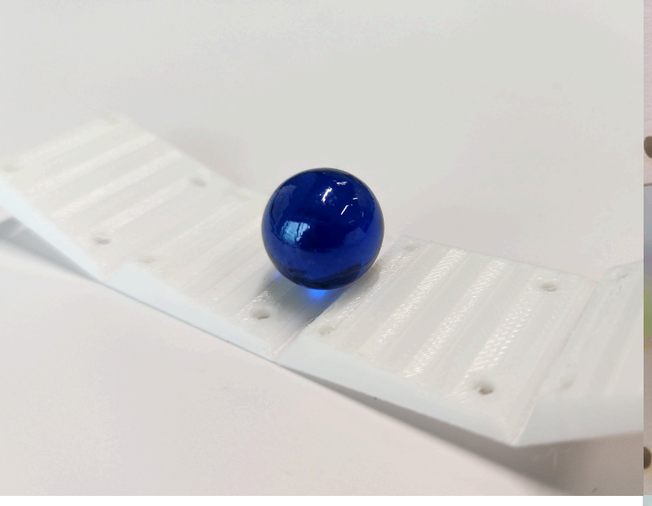
“Good design is actually a lot harder to notice than poor design.”

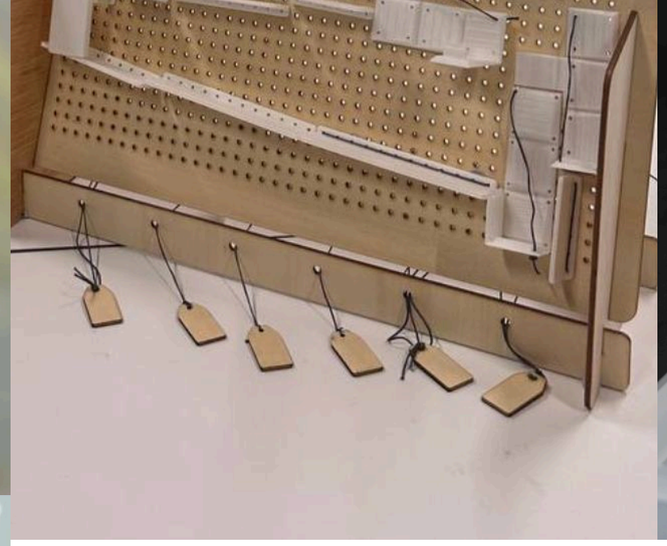
Don Norman
The Design of Everyday Things

No matter how well an experience is designed, it fails if the interaction feels unreliable. In Cubic Rhythms, every cube must fold and unfold reliably, and every marble must roll consistently to the next cubes. In digital games, it is ensured by good code and interaction design. In physical games, it requires extensive iteration, material testing, and an understanding of real-world physics to make interactions feel seamless and dependable.

Understanding the Cube Nets

Our first hurdle was designing the cube nets themselves. We began with cardboard prototypes to explore the 11 possible cube net patterns and identify which could carry a marble. While useful for early and rapid testing, cardboard proved unsuitable beyond low-fidelity prototypes, as marbles did not reliably roll off flat surfaces.

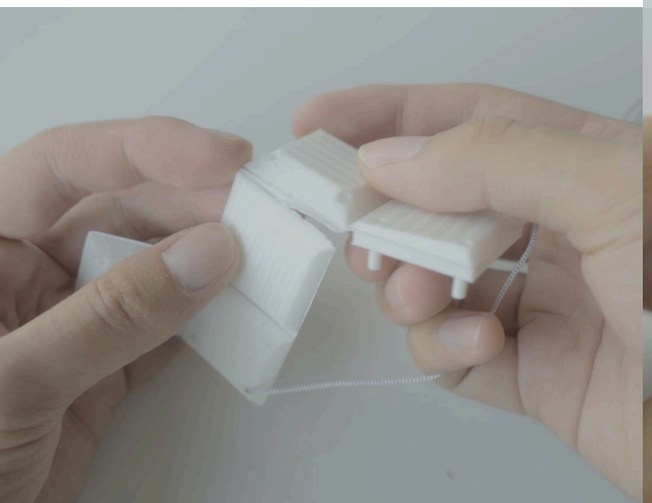


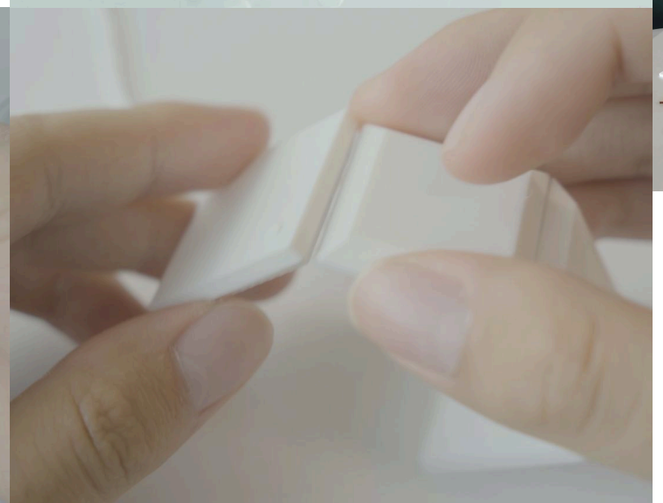


Making Unfolding Automatic

We explored 3D-printed cube nets with living hinges, allowing us to design built-in slopes that helped marbles roll in and out reliably. However, the printed hinges were too rigid and could not unfold automatically when the string was released.

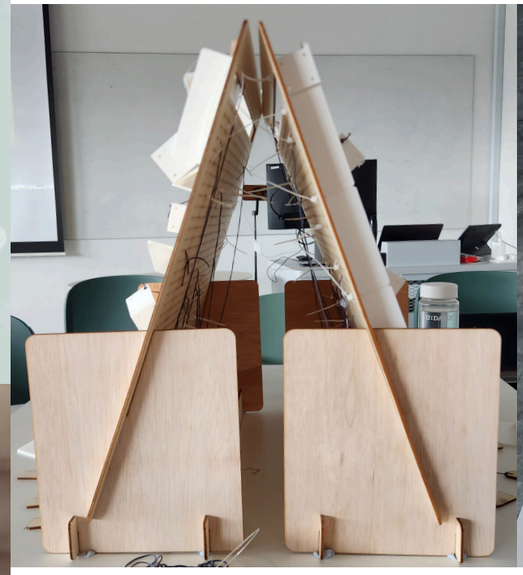
We tested alternative hinge materials using paper and PVC sheets. Paper tore too easily under repeated folding, while PVC proved durable, flexible and capable of unfolding on its own, making it the ideal choice.

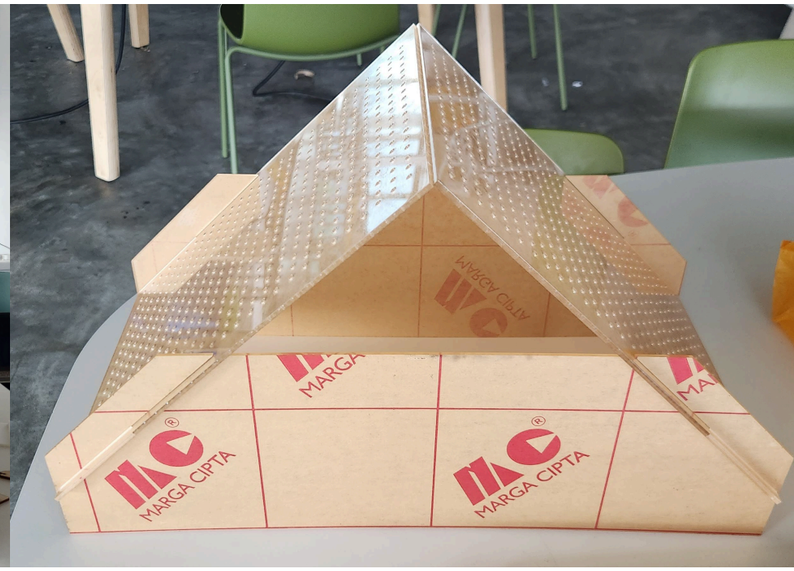




Refining Game Controls

Initially, cube nets were activated using loose string tags. This lacked precision and made it difficult to control multiple cubes. We redesigned the actuation system into sliders arranged neatly along the board. Each slider corresponds to a column, creating a clear mapping between the slider and the cubes that it controls. The sliders can be activated with a single finger, allowing for easy manipulation of multiple sliders. Two red sliders at the sides control the final launcher. Their colour and placement differentiate this action from the regular cube folding, serving both as signifiers and as a moment of climax.





Controlling Marble Movement

Marbles are highly sensitive to angle, the slightest tilt is enough to make it roll. Through testing, we determined that a 45-degree slope on the game board is the most suitable. Steep enough to ensure movement, yet gentle enough to prevent the marble from falling too far down.

“Complicating is easy. Simplifying is difficult.”

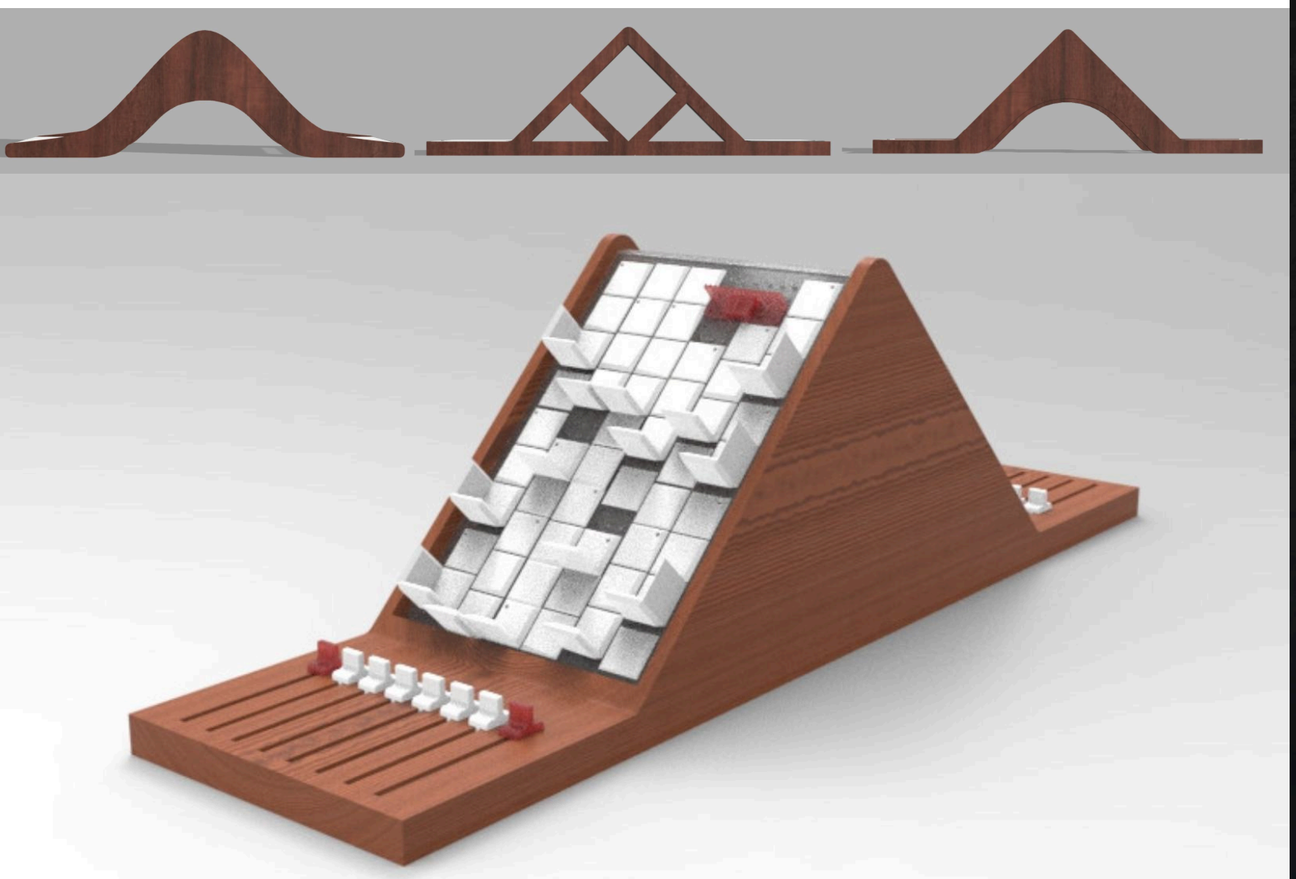
Bruno Munari

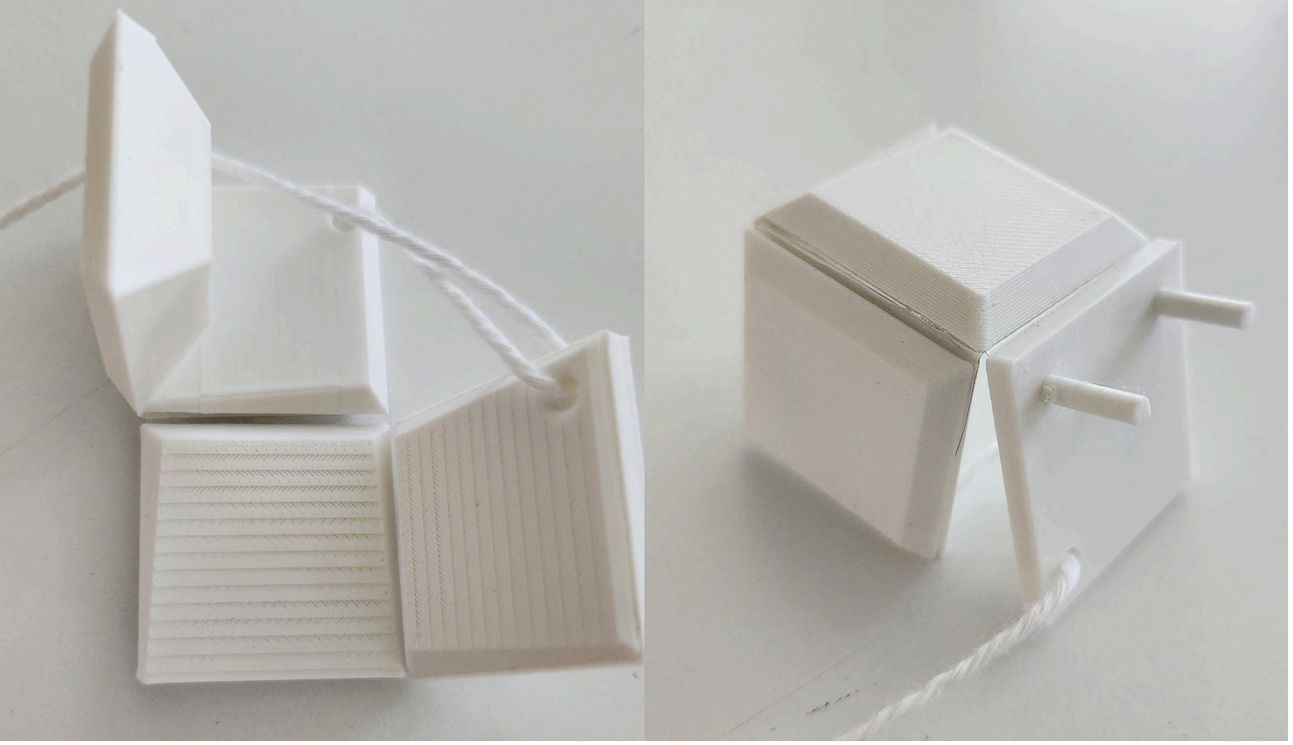
Board Design: Reducing Complexity to Simplicity

The board went through multiple iterations, from wooden frames with transparent panels to patterned surfaces, before we settled on a minimal, single-material approach.

The final design uses frosted acrylic sheets, laser-cut and heat-bent to form clean panels with soft corners. This material complements the white 3D-printed cube nets while simplifying fabrication.

The shift towards simpler mono-material approach hammered in us how simplicity allows easier manufacturing and a cleaner aesthetic, focusing the spotlight to fall to the main mechanism and the gameplay.



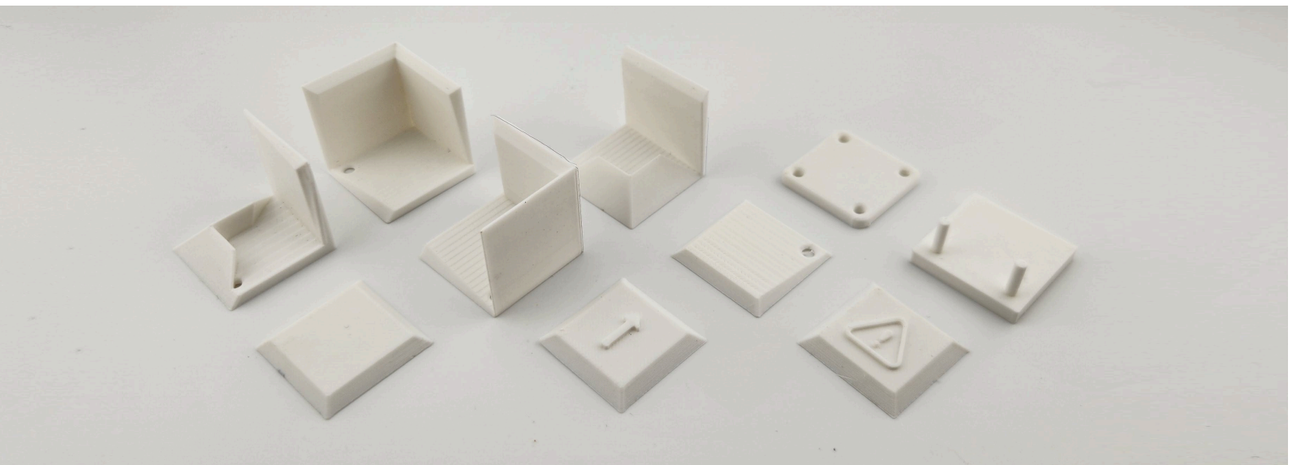


Cube Net Refinement: Complexity to Form Simplicity

The cube nets, however, take an entirely different approach. Continuously folding and transferring marbles, they demand a greater precision. Each net was constructed from multiple 3D-printed panels attached to a PVC backing, all printed in the same orientation with a finer layer height to ensure a smooth, uniform finish.

Besides the sloped panel used to ensure rolling, we designed receiving elements intended to catch marbles from the previous cube. Each cube net also has a panel with pegs to secure the cube net to the board, locked by another panel from behind. A simple covering panel ensures uniform look across all cube nets. Some panels with symbols provide hints.

Each different element comes together to form a single cube net. Different variations of the cube nets require different set of elements. Every detail was adjusted to ensure the cube nets look seamless and function reliably.



Play as Educational Tool

Cubic Rhythms demonstrates how educational value can be embedded naturally within a playful, interactive game. It uses cube nets, commonly introduced to illustrate how two-dimensional surfaces transform into three-dimensional shapes, as the core gameplay mechanism. By integrating these structures directly into interaction, the game offers a low-barrier, hands-on way to experience spatial transformation. Players can see and feel a flat structure become a three-dimensional object, allowing understanding to emerge through action rather than explanation.

As players progress, the game encourages the players to reason about it as an interconnected system. Each cube net influences adjacent pathways, and a single pull can alter multiple routes simultaneously. To advance, players must recognise relationships between components and anticipate how their actions affect the behaviour of the maze as a whole. Solving the puzzle therefore becomes less about reacting to isolated events and more about understanding the system in its entirety.

Cause and effect also play a central role. Every pull produces a visible outcome. It may leave the marble unchanged, transfer it forward, or cause it to fall back. Through repeated attempts, players experience how individual actions lead to consequences and how the order of actions is crucial to solving the game. We observed strong parallels with programming logic: each pull functions as an input, each fold changes the state of the system, and the marble’s movement becomes the output. In this sense, players are physically “programming” the marble’s path through the maze.

At a time when many learning experiences are mediated through screens, Cubic Rhythms brings problem-solving back into the physical world. Governed by gravity, material behaviour, and mechanical constraints, the game makes these forces visible and understandable through play. It demonstrates that logical thinking, systems reasoning, and meaningful learning can emerge from carefully designed physical interaction.

Conclusion

Cubic Rhythms exemplifies how experience, interaction, and product design are deeply interconnected and evolve together through making and testing. In an era increasingly dominated by digital experiences, the project serves as a reminder of the richness of the physical world. Without electronics, screens, or batteries, Cubic Rhythms relies on string mechanisms, gravity, and human input to deliver challenge and play.

Beyond entertainment, the project highlights the educational potential of physical systems, demonstrating how cause-and-effect relationships and computational thinking can be explored through tangible interaction. By combining marble runs and cube nets, the game introduces new forms of interaction and gameplay. Cubic Rhythms shows that physical play still holds vast, largely unexplored potential, capable of producing experiences that are just as engaging, intelligent, and memorable as those found in digital systems.

Acknowledgements

We would like to express our sincere gratitude to our supervisor, Donn Koh of the NUS Division of Industrial Design, whose guidance was instrumental to this project, as well as to all the players whose valuable feedback shaped Cubic Rhythms across its iterations.