Picovo

Game Title	Picovo
Category	A' Game Design Award [Cat.175]
Genre	Multiplayer Mobile AR Party Game
Platform	iOS and Android
Engine	Unity 2022.3 with AR Foundation 5.1
Networking	Photon PUN2, Node.js + Redis + MongoDB
Institution	China Academy of Art, School of Design and Innovation
Location	Hangzhou, China
Duration	September 2025 to January 2026
Team	Xiaoyue Shan, Zijin Jiang, Naizhen Luo, Zhutian Fan

Picovo is a multiplayer augmented reality game that reframes AR plane detection as a narrative medium. Rather than treating physical surfaces as invisible scaffolding for virtual content, Picovo transforms detected planes into contested territories where 2 to 4 players compete as coating workers in a speculative 2036 setting. Through 36 playtesting sessions across varied room configurations, the team identified three transferable spatial design patterns that convert room topology into emergent story structures without any scripted content.

01. Worldview and Game Overview

World Setting

The year is 2036. Digital technology has merged deeply with physical reality. Every surface in the real world has become a programmable interface. Picovo Corporation provides digital coating and maintenance services exclusively for real-world spaces. As an aspiring coating worker you dream of joining this industry leader. After passing multiple rounds of screening, you have earned the right to enter the final practical test.

You and your rivals enter a live test arena. Within a limited time, you must complete as many coating orders as possible. The highest earner wins the position and becomes a member of Picovo.

Game Concept

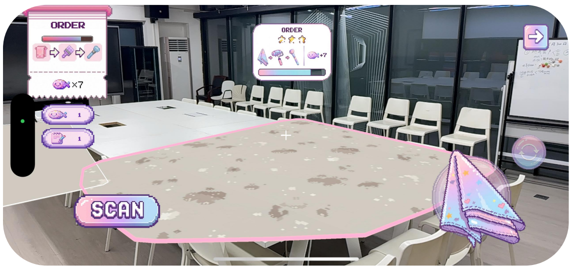
Picovo is a real-time competitive multiplayer AR game. Players scan and activate virtual planes in physical space, complete coating orders to earn rewards, and simultaneously interfere with opponents' progress. The game fuses a painting-logic tool counter system with real-time spatial strategy and social competition.

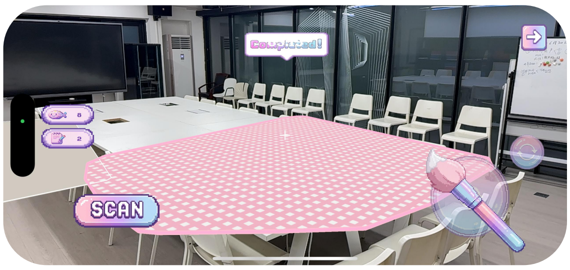
Game Phases

Phase	Description
Preparation	The system generates random planes around players. Players scan surfaces, place the workbench, and familiarize themselves with the arena.
Free Competition (5 min)	Players claim orders, collect tools, complete coating sequences, and interfere with opponents.
Climax Phase	Large order spawn probability increases sharply. Players are rewarded for interfering with each other's progress, driving maximum chaos.
Settlement	Total earnings are tallied. Rankings determine the winner.

Core Design Premise

Picovo asks a fundamental design question: what if AR-detected surfaces are the narrative subjects themselves, rather than passive supports for virtual content? Location-based AR games anchor play to GPS coordinates; room-scale platforms use plane detection solely for object placement. Picovo inverts this convention entirely. The room layout becomes the game design. The furniture arrangement becomes the level. The distance between objects becomes the dramatic tension.





02. Key Features and Market Position

Core Selling Points

Feature	Description
AR Fragmented Battlefield	The real environment is the game field. Surfaces are randomly detected and activated, making every play session unique.
Painting Logic Counter System	Cloth, Roller, and Brush follow a three-step painting workflow forming a wipe-coat-pattern interference cycle.
Order Racing Mechanic	Dynamically refreshing orders emphasize rapid decision-making and route planning.
Attack and Defense Unity	Each tool simultaneously advances your own task and can sabotage opponents' progress.

Product Advantages

Advantage	Detail
Clear Differentiation	In a market saturated with scan-collect-display AR games, Picovo focuses on real-time competitive confrontation, creating a strong product identity.
Low Learning Cost	The core flow is minimal: scan, accept order, wipe, coat, pattern, submit. Three tools, but strategic depth through sequence and counter relationships.
Strong Social Attributes	2 to 4 players compete in shared AR space with visible actions. Interference is highly performative, generating laughter and social memory that spreads naturally.

Target Audience

Picovo targets social party players aged 16 to 35 who gather in physical spaces such as classrooms, offices, parties, and offline events. The ideal player prefers simple rules combined with strategic depth in a joyful, low-pressure atmosphere. The game is designed for accessibility without sacrificing replay value.

Competitive Positioning

Against the backdrop of heavy homogenization in AR games (scan, collect, display), Picovo clearly positions itself as a real-time competitive social experience. It can be easily categorized as a party AR game, which benefits word-of-mouth spread and scenario-based marketing across social platforms.

03. Gameplay Mechanics

Core Game Flow

Players scan physical surfaces to activate AR planes and accept coating orders. Each order requires sequential tool application: Cloth (Dirty to Clean), Roller (Clean to Color), and Brush (Color to Pattern). Tools are collected one at a time from the shared central workbench. Only one interaction per surface at a time. Orders auto-submit on completion; failure to finish before the timer deducts a penalty. The player with the highest fish token count wins.Tool System and Counter Mechanics

"Each tool is simultaneously a means to advance your own task and a weapon against your opponent."

Tool	Primary Function	Interference Effect	Limitations
Cloth	Wipe dirty surface (Dirty to Clean)	Strips applied color from any surface, reverting one step	Can affect both players' surfaces
Roller	Apply base color (Clean to Pink/Blue)	Overwrites opponent's base color with your own color	Cannot interfere with medium orders once color is applied
Brush	Complete pattern on base color (final step)	No interference function	Pure completion tool only

Counter rule: same-stage actions cannot interfere with each other. Tool function must match the surface state to interact.

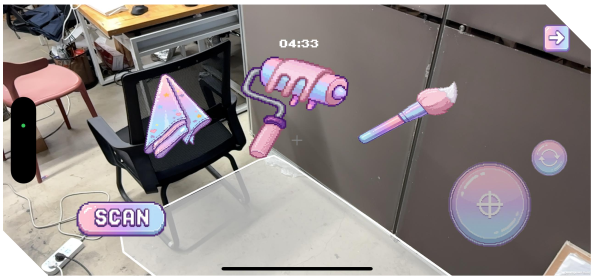
Order System

Tier	Stars	Spawn Rate	Time Limit	Reward	Penalty	Material Flow
Small	1	50%	15 sec	+1 token	-1 token	Dirty to Clean
Medium	2	35%	30 sec	+3 tokens	-2 tokens	Dirty to Clean to Color
Large	3	15%	45 sec	+7 tokens	-3 tokens	Dirty to Clean to Color to Pattern

During the final 60 seconds, large order spawn probability increases sharply and successful interference bonuses double, driving maximum player interaction.

Economy and Victory System

The fish token economy rewards both order completion and strategic interference. Each successful interference awards 5 bonus tokens. The settlement screen displays completed orders, interference count, and total earnings per player. Tiebreaker priority: (1) total orders completed, (2) large orders completed.



04. The Workbench: Core Spatial Constraint

The shared virtual workbench is the single most critical design decision in Picovo. Positioned at the center of the play space, it is the only location where players can obtain or switch tools. This single constraint transforms the entire room into a strategic battlefield.

Workbench Rules

Rule	Detail
Fixed Position	The workbench is placed once at the start of the session at the center of the play area. All players share one workbench.
One Tool at a Time	Players may carry only one tool. To switch, they must physically return to the workbench, put down the current tool, and pick up a new one.
Strategic Core	Tool selection and movement path planning around the workbench form the central strategic layer of the game.
Shared Resource	The workbench is contested space. Multiple players arriving simultaneously must sequence their interactions.

Design Rationale: The Breakthrough

In early prototypes, players freely switched tools via a UI menu anywhere on the screen. Playtests were mechanically functional but narratively inert: players optimized silently, rarely spoke, and never referenced physical space. The game had no spatial stories.

The introduction of the workbench was the breakthrough. Players now had to physically leave claimed surfaces to change tools. Each departure created a moment of vulnerability that opponents could exploit. In the very first session with the workbench, a player shouted 'Don't touch my table', the first instance of spontaneous possessive spatial language observed after weeks of testing. Physical displacement had become a narrative engine.

Distance Calibration

Distance Range	Effect
Under 1.5 m	Tool switches feel costless. Vulnerability disappears. Gameplay becomes flat and narratively inert.
2 to 5 m (optimal)	Departure creates real risk. Return remains viable. Dramatic tension is sustained throughout the session.
Over 6 m	Players abandon distant surfaces entirely. Strategic complexity collapses into proximity-only play.

Interaction radius: 1.5 m. Vulnerability duration = traversal distance divided by walking speed (approximately 1.2 m per second). This coupling of physical distance and time converts room layout into dramatic structure.

05. Online Multiplayer System

Picovo supports 2 to 4 players competing in the same AR arena in real time. The networking system is built on Photon PUN2, with a backend using Node.js, Redis, and MongoDB for low-latency, high-stability multiplayer sessions.

Room Creation and Joining

Function	Detail
Room Creation	The host creates a room and generates a unique 6-character alphanumeric room code. Parameters: session duration, maximum players (2 to 4), and public/private visibility.
Room Joining	Players enter the room code directly, use quick match (auto-matched by rank), or join via friend invitation link.
Host Controls	The host can start the game, kick players, and adjust settings before the session begins.

Plane State Synchronization Architecture

Maintaining consistent AR plane states across multiple devices is the core technical challenge in Picovo. The system uses an authoritative server model with the following flow:

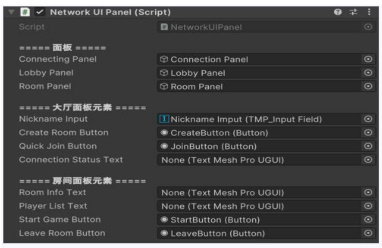
Step	Action
1	Client A performs an action on a surface
2	Action request is sent to the server
3	Server validates the action's legality
4	Server updates the authoritative state
5	State change is broadcast to all connected clients
6	Each client updates its local display

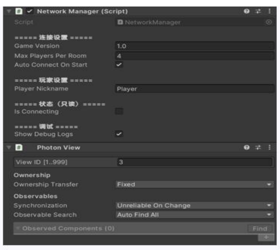
Shadow Plane Protocol

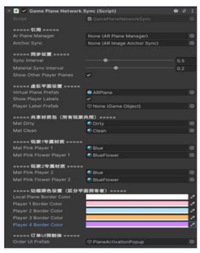
Each device detects AR planes independently, producing different boundaries and timing. LiDAR-enabled devices are approximately 1.5 seconds faster. The Shadow Plane Protocol resolves this: the host device broadcasts authoritative plane data (centroid, extent, alignment, boundary vertices) via Photon PUN2. Remote devices instantiate simplified colliders based on this broadcast. A two-second stability filter prevents flickering. This reduced plane inconsistency errors from approximately 40 percent to under 3 percent of sessions.

Game State Machine

GameModeManager controls the session lifecycle: Connect, Lobby, Room, Game, Settlement. The UI panel responds to user actions and GamePlaneSync maintains core data consistency across all connected devices throughout each phase.







06. Research Findings: Topology Shapes Narrative

Picovo was developed alongside an empirical research study investigating how physical topology shapes emergent narrative in AR multiplayer games. 36 sessions were conducted across three room topology types with 72 participants aged 18 to 58.

Physical Space vs Stationary Baseline

Metric	Stationary Baseline	Picovo
Physical movement per session	31 m	147 m
Narrative engagement score (out of 7)	2.7	5.4
Spontaneous narrative language	0.8 utterances per min	5.1 utterances per min
Unprompted replay requests	1 of 72 participants	31 of 72 participants

F(1,69)=168.4, p less than .001 for movement increase. Narrative engagement adapted from Busselle and Bilandzic 2009, alpha=.79.

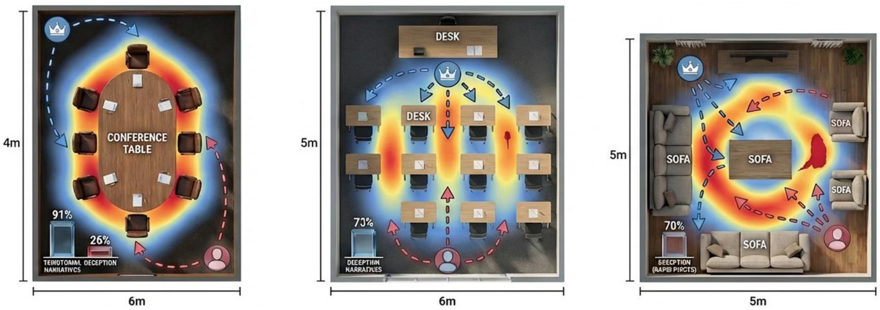
Topology-Dependent Narrative Patterns

Room Type	Mean Distance	Dominant Narrative	Key Player Behavior
Conference Room (6 large planes)	5.2 m	Territorial (91%)	Long distances amplify ownership. Players sprint to defend claimed surfaces. Only 26% deception behavior.
Classroom (12 mixed planes)	3.4 m	Deception (73%)	Moderate distances enable deliberate misdirection. Players report feinting toward walls.
Living Room (mixed sizes)	1.8 m	Rapid Pivots (70%)	Short distances produce multi-surface cascading reversals. Rapid tool switching and territory flipping.

Mean distance correlated with territorial framing (r=.59) and inversely with deception (r=-.41). Post-session interviews yielded approximately 340 pages of qualitative data (Cohen kappa=.86).

Three Emergent Spatial Design Patterns

Pattern	Mechanism	Design Implication
Territorial Inscription	Progress visualization anchored to real geometry makes labor and vulnerability legible	High-contrast persistent surface states turn detected planes into owned territory
Vulnerability Rhythm	Mandatory workbench trips create polyrhythmic movement; vulnerability = distance / speed	Room layout directly determines dramatic pacing without any scripted content
Legible Threat	1.5 m interaction radius makes opponent proximity an unambiguous spatial signal	Players read intention through body movement rather than screen indicators



07. Design Process and Iteration

Iteration	Change	Outcome
1: Free Tool Access	Players switch tools freely via UI menu anywhere	Mechanically functional but narratively inert. Players optimized silently and never referenced space.
2: Workbench Introduction	Single shared workbench placed at arena center	Breakthrough. First spontaneous spatial language emerged. Physical displacement became a narrative engine.
3: Distance Calibration	Tested workbench distances from under 1.5 m to over 6 m	Converged on 2 to 5 m optimal range. Interaction radius set at 1.5 m through testing.
4: Visual Effect Iteration	Tested solid fills, animated patterns, pixel art overlays, character mascots	16-bit pixel art with macaron color coding selected for readability and ownership clarity.
5: Multi-Space Testing	36 sessions across conference rooms, classrooms, living rooms	Topology-dependent narrative confirmed. Three design patterns formalized.

Key Lesson

The most scripted version of Picovo was narratively inert. The most spatially constrained version produced stories the team never anticipated. Spatial narrative design is fundamentally about constraint placement: where you position the workbench matters more than any content that could be scripted into the game.

Cross-Device Technical Challenges

The team attempted multiple plane-matching algorithms before developing the Shadow Plane Protocol. Early approaches included: (1) centroid proximity matching, which failed due to boundary variance; (2) semantic surface classification, which was too slow for real-time use; (3) timestamp synchronization, which failed due to LiDAR speed differences. The final authoritative broadcast model solved all three failure modes simultaneously.

08. UI and UX Design

Visual Design Language

Picovo uses a 16-bit pixel art visual style with a macaron color palette combining soft pink, light purple, and pastel blue. The rounded design language creates a healing visual experience that blends pixel art with modern UI elements, presenting a retro-meets-contemporary aesthetic. The soft colors and playful character elements deliberately lower competitive stress, making the game approachable for casual players while maintaining clear visual information hierarchy.

HUD Architecture

Element	Position	Function
Status Bar	Top	Remaining session time and current fish token count
Tool Icon	Center-left	Currently held tool display with fade-in/fade-out animation
Order Progress Bar	Left panel	Current task step completion with step indicator
Interference Feedback	Center screen	Attack received or successful interference notification
SCAN Button	Bottom-left	Surface detection and activation trigger
Workbench Display	3D world space	Floating tool selection UI above workbench in real-world position

Multiplayer Lobby Interface

The lobby is designed around a pixel-art sketchbook metaphor communicating the creative and tactile theme of the game. The interface includes room code display, player list, settings panel for duration and player count, and host controls. The design is optimized for rapid social media sharing and second-hand dissemination.

Onboarding Tutorial

The tutorial screen presents all essential rules in a single pre-game overlay: the three-step painting workflow (Wipe, Base, Pattern), tool cycle, order mechanics, interference rules, and win condition. Mean time to first meaningful gameplay action across all test participants was under 90 seconds, including participants with no prior mobile gaming experience.

Settlement Screen

Both single-player and multiplayer settlement screens display completed order count, interference count, and total earnings per player. Rankings are presented with trophy animations. The settlement data is designed to generate social comparison and prompt immediate replay requests.

10. Research Background and Related Work

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AR Spatial Interaction

Existing AR games treat physical surfaces as invisible scaffolding. Location-based games such as Pokemon GO and Ingress anchor play to GPS coordinates, while room-scale platforms use plane detection solely for virtual object placement. Recent work on AR storytelling by Shin and Woo (2023) confirms that spatial trajectories carry narrative intent, and Dong et al. (2022) demonstrate that scene semantics can guide automatic placement of authored story content. However, these systems author narratives into space rather than letting space author narrative. Trajectories are designed, and content is pre-written. Picovo inverts this convention by asking whether physical topology alone can generate distinct story structures without any scripted content.

Embodied Interaction

Dourish (2001) established that meaning emerges from physical engagement with the world rather than symbolic representation alone. Mueller et al. (2022) extend this to human-computer integration, proposing that the body itself becomes the primary interface between player intent and spatial computation. Picovo operationalizes this principle directly: the workbench constraint forces players to commit their bodies to spatial decisions, making physical movement the primary game mechanic rather than a byproduct of interaction.

Environmental Storytelling

Jenkins (2004) argues that game designers function as narrative architects, constructing spaces that enable story rather than scripting it. Salen and Zimmerman (2004) further establish that rules generate meaning through player action rather than authored content. Picovo extends these frameworks into AR by demonstrating that detected room topology, including surface distribution, traversal distance, and fragmentation density, systematically produces distinct narrative structures across different spatial configurations.

Primary Research

The design and research findings of this project are documented in the academic paper "Picovo: Surfaces as Contested Spatial Narratives", submitted to SIGGRAPH 2026 in the Spatial Storytelling category (submission under review, gensub_273s1). The paper presents empirical data from 36 playtesting sessions across three room topology types with 72 participants, and formalizes three transferable spatial design patterns: Territorial Inscription, Vulnerability Rhythm, and Legible Threat.

Storytelling. CHI '23. ACM.

PICOVO: Surfaces as Contested Spatial Narratives

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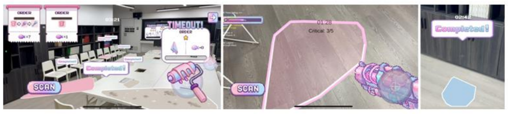

Figure 1: In-game visuals from PICOVO. From left to right, the images show detected physical surfaces transformed into interactive territories, players contesting these surfaces through tool-based actions, and completion feedback embedded directly in the physical environment.

ABSTRACT

PICOVO reframes AR plane detection as narrative substrate: detected surfaces become contested territories that players physically defend. This submission reveals the design process behind this reframing—how iterative prototyping across distinct spatial topologies led us to discover that environmental geometry itself generates emergent story structures. We detail the spatial mechanics we developed, the failures that shaped them, and a demonstration designed to let attendees experience and manipulate the topology–narrative relationship firsthand.

CCS CONCEPTS

• **Human-centered computing** → Mixed / augmented reality; Interaction design theory, concepts and paradigms; • **Applied computing** → Arts and humanities; • **Software and its engineering** → Multiplayer online games.

KEYWORDS

Embodied Interaction, Spatial Computing, AR Game Design, Emergent Spatial Narrative, Mobile AR

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1 MOTIVATION: SURFACES AS STORY

When AR systems detect a table, they treat it as invisible scaffolding for virtual objects. We asked: what if detected surfaces are the narrative subjects—not the supports?

This question emerged from a frustration. Location-based AR games (Pokémon GO, Ingress) anchor play to GPS coordinates; room-scale platforms use plane detection solely for object placement [4, 8]. Recent work on embodied AR [3, 9, 14] and environmental storytelling [7, 10] establishes that spatial configuration generates narrative meaning. Shin and Woo [12] confirm that spatial trajectories carry narrative intent in AR heritage contexts, and Dong et al. [13] demonstrate that scene semantics can guide automatic placement of authored story content in AR environments. Yet these systems author narratives *into* space rather than letting space author narrative.

Trajectories are designed, and content is pre-written. We wanted to explore whether physical topology alone could produce distinct story structures without any scripted content.

2 THE DESIGN JOURNEY: WHAT WORKED, WHAT DIDN'T

2.1 First Attempt: Free Tool Access

Our initial prototype let players freely switch tools anywhere via a UI menu. Set in a speculative 2036 where surfaces are programmable, 2–4 players compete as coating workers across randomly detected planes.

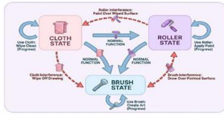

Figure 2: Tool State Machine. Sequential tools enable asymmetric interference under limited usage.

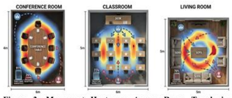

Figure 3: Movement Heatmaps Across Room Topologies Conference rooms (5.2m) yield territorial play (91%), classrooms (3.4m) enable deception (73%), living rooms (1.8m) produce rapid pivots (70%).

ARKit/ARCore finds horizontal and vertical surfaces as "dirty" work orders (small/medium/large tier); environmental topology determines the play space—furniture-dense rooms yield fragmented territories while open spaces create contested zones. Orders require sequential tool application (Cloth→Roller→Brush), with asymmetric interference (Figure 2): Cloth strips progress, Roller overwrites with player color, Brush only completes. Early playtests were mechanically functional but narratively dead—players optimized silently, rarely spoke, and never referenced space. We had built a spatial game that produced no spatial stories.

2.2 The Workbench Breakthrough

We introduced a shared virtual workbench for tool switching, a single spatial constraint that transformed player behavior. Players now had to physically leave claimed surfaces to change tools, and each departure created a moment of vulnerability that opponents could exploit. The distance between the workbench and a surface became a source of dramatic tension. A player coating a distant table had to choose between completing the task and risking the loss of progress during a long return trip.

In the first session using the workbench, a player shouted, "Don't touch my table," marking the first instance of spontaneous possessive language observed after weeks of testing. Physical displacement had become a narrative engine. Players began narrating their own actions by framing departures as sacrifices, returns as rescues, and opponents' approaches as invasions.

2.3 Parameter Tuning Through Failure

Early workbench placement was arbitrary. When placed too close (<1.5 m) to surfaces, tool switches felt costless and vulnerability disappeared. When placed too far (>6 m), players abandoned distant surfaces entirely—strategic complexity collapsed.

We converged on 2–5 m as the productive range where departure created real risk but return remained viable. Similarly, the 1.5 m interaction radius emerged from testing: smaller radii forced awkward precision; larger radii eliminated the legible body-language of threat.

2.4 Three Emergent Spatial Patterns

Through this iterative process, we formalized three design patterns, drawing on Dourish [3], Benford [1], and Mueller et al.'s framework for human–computer integration [14], where the body itself becomes the primary interface between player intent and spatial computation:

(1) Territorial Inscription. Progress visualization anchored to real geometry makes labor and vulnerability legible. Persistent, high-contrast surface states turn detected planes into owned territory.

(2) Vulnerability Rhythm. Mandatory workbench trips create polyrhythmic movement. Vulnerability duration = traversal distance / walking speed (~1.2 m/s). This coupling of distance and time is the core mechanism converting room layout into dramatic structure.

(3) Legible Threat. The 1.5 m interaction radius makes opponent proximity an unambiguous spatial signal. Players read intention through body movement rather than screen indicators.

These patterns require physical topology: room layout determines workbench–surface distances (vulnerability duration), surface distribution (territorial fragmentation), and movement visibility (threat legibility).

3 IMPLEMENTATION INSIGHTS

Built in Unity 2022.3 with AR Foundation 5.1, targeting iPhone 14 Pro and Galaxy S22 (>56 fps). Co-localization uses a printed AR image marker (<3 cm positional, <2° rotational error).

The most challenging technical issue was cross-device plane consistency. Each device detects planes independently, producing different boundaries and detection timing. LiDAR-enabled devices are approximately 1.5 seconds faster. After several failed attempts at plane matching algorithms, we developed a Shadow Plane Protocol. The host device broadcasts authoritative plane data, including centroid, extent, alignment, and boundary vertices, via Photon PUN2. Remote devices then instantiate simplified colliders based on this broadcast, eliminating plane inconsistency. A two-second stability filter prevents flickering caused by unstable detections.

4 WHAT THE SPACES TOLD US

We ran 36 sessions (N=72, ages 18–58) across three topology types to understand what role space played.

Does physical space matter at all? Compared to a stationary baseline with identical mechanics but no physical movement, PICOVO produced dramatically different engagement. Physical movement increased from 31 m to 147 m per session ($F(1,69)=168.4$, $p<.001$). Narrative engagement (adapted from Busselle & Bilandzic [2], $\alpha=.79$) rose from 2.7 to 5.4. Spontaneous narrative language—utterances about ownership, threat, and reversal—increased sixfold (5.1/min vs. 0.8). Unprompted replay requests: 31/72 PICOVO vs. 1/72 baseline.

Do different topologies produce different stories? Yes, systematically (Figure 3). Post-session interviews (~340 pages, Cohen's $\kappa=.86$) revealed topology-dependent narrative patterns:

- ***Conference rooms*** (6 large planes, mean distance 5.2 m): 91% territorial narratives, only 26% deception. Long distances amplified ownership but prevented effective feinting.
- ***Classrooms*** (12 mixed planes, mean distance 3.4 m): 73% deception narratives. Moderate distances enabled deliberate misdirection—"I faked going to the wall."
- ***Living rooms*** (mixed plane sizes, mean distance 1.8 m): 70% deception via rapid pivots; multi-surface cascading reversals.

Mean distance correlated with territorial framing ($r=.59$) and inversely with deception ($r=-.41$). Environmental confounds (room formality, object semantics) exist; preliminary furniture-rearrangement sessions ($n=8$) suggest spatial metrics dominate, but controlled manipulation studies are needed.

5 DEMONSTRATION: EXPERIENCING THE PROCESS

The demonstration is the research process itself, as attendees discover topology and narrative relationships through embodied play.

Stage 1: Uninformed Play (6 min). Four attendees play PICOVO in a pre-configured space with mixed distances (~2 m / ~5 m), given only task-completion and sabotage instructions. A shared display shows real-time movement trails, tool-switch frequency, and live transcription of spatial language—making the process legible as it unfolds.

Stage 2: Process Reveal (8 min). We replay key moments from Stage 1, highlighting correlations between distance and narrative behavior: long-distance stations producing territorial language and defensive sprints, close-range stations producing rapid deception and feints. Attendees then manipulate topology via a tablet interface—dragging the workbench position, toggling surfaces on/off, and adjusting interaction radii. A lightweight predictive overlay (heuristic model trained on our playtest data) updates expected narrative tendencies in real time, showing how each spatial change shifts the balance between territorial and deception narratives. One modified configuration is briefly tested, letting attendees verify the prediction against their own experience.

Stage 3: Attendee-Led Design (6 min). Attendees physically rearrange furniture and place a new AR anchor. The system scans the resulting topology, visualizes spatial metrics, predicts dominant narrative tendencies, and exposes internal processes—plane synchronization events, FSM state transitions, vulnerability timers—during live play. The three design patterns become directly observable as spatial parameters change.

Setup: 4 phones, 1 tablet, 2 displays, ~5×5 m area with movable furniture.

Core insight: By playing, modifying, and replaying space, attendees experience firsthand how spatial configuration alone generates distinct narrative behaviors—without scripted story.

6 DISCUSSION: TOPOLOGY SHAPES NARRATIVE

PICOVO's contribution is a discoverable principle that physical topology determines emergent narrative structure, a principle we reached not through theoretical reasoning but through iterative making and breaking. The three parameterized patterns, territorial inscription, vulnerability rhythm, and legible threat, emerged from observing players across dozens of failed and successful spatial configurations. These patterns are transferable beyond games, including museum AR in which exhibits become contested territories, collaborative design review where CAD surfaces carry ownership stakes, and physical therapy AR where body part targets generate movement based narratives.

Our process taught us that spatial narrative design is fundamentally about constraint placement: the workbench's position matters more than any content we could script. The most scripted version of PICOVO was narratively inert; the most spatially constrained version produced stories we never anticipated. Future work includes controlled topology manipulation within constant environments, longitudinal studies with pre-existing social groups, and accessibility-centered adaptations (gesture-based claiming, adjustable interaction radii) for users with mobility limitations.

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11. Team and Technical Specifications

Team

Name	Role	Specialization
Xiaoyue Shan	Lead Designer and Developer	AR interaction design, Unity development, spatial narrative research, project direction
Zijin Jiang	Game Architect	Game-XR architecture, 3D tool asset modeling, virtual narrative methodology, UE5
Naizhen Luo	Technical Developer	Real-time rendering, VFX systems, Unity engineering, industrial optimization
Zhutian Fan	Media Production	Video editing, promotional materials, gameplay documentation, After Effects, Premiere Pro

Technical Specifications

Specification	Value
Target Platforms	iOS (iPhone 14 Pro and above), Android (Galaxy S22 and above)
Performance Target	56 fps and above on target devices
AR Framework	AR Foundation 5.1 (ARKit and ARCore)
Multiplayer	Photon PUN2, Node.js + Redis + MongoDB backend
Co-localization	Printed AR image marker (under 3 cm positional, under 2 degree rotational error)
Play Area	Approximately 5 by 5 meters with movable furniture
Player Count	2 to 4 players per session
Session Duration	5, 7, or 10 minutes (host selectable)
Workbench Interaction Radius	1.5 m
Optimal Workbench Distance	2 to 5 m from surfaces