Appendix F — World Models Developed by YVision

YDreams / YVision · 2010–2026

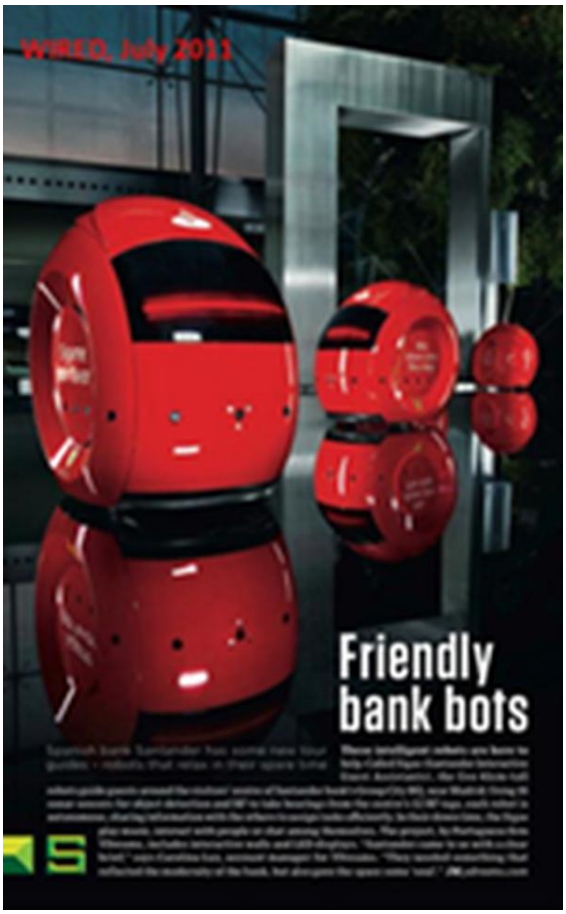
This appendix documents the lineage of world models built and deployed by YDreams and YVision between 2010 and 2026.

Each project is described as a formal M³C World Model instance — demonstrating that YVision's theoretical framework

is grounded in decades of real-world deployment across cities, infrastructure, health, sport, ecology, and immersive media.

F.1 Santander Financial City — Robots + 3D Model + AR

DOMAIN	Urban / Corporate Digital Twin · Spatial Computing · Embodied AI · Augmented Reality



Santander Financial City: intelligent robot guides navigating within an AR-enhanced 3D physical model.

What Was Built

- A 3D physical scale model of Santander Financial City
- Augmented Reality overlays tied to model components
- Intelligent robots guiding visitors and explaining spatial elements
- Dynamic display explanations updated in real time

Why This is a True World Model

The physical terrain model was linked to live databases. Each spatial object — buildings, trees, infrastructure components — was data-bound, making the model semantically alive. AR overlays updated meaning in real time as visitors interacted. Robots navigated and interacted within that mapped spatial representation, demonstrating autonomous agency within a structured world model.

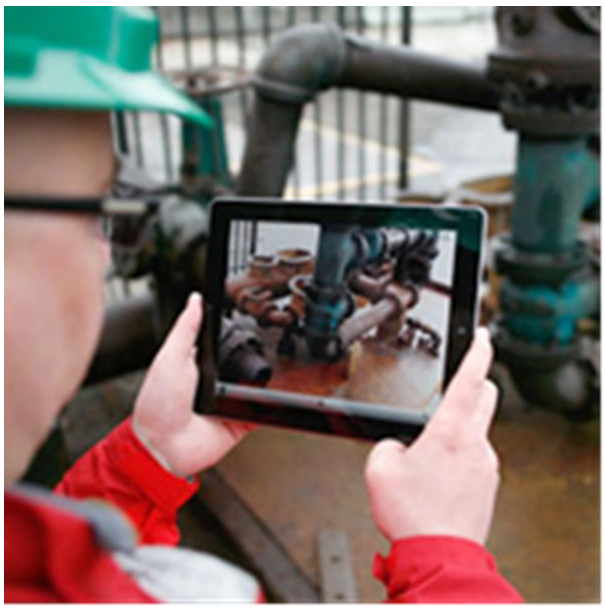
> M³C Classification: A structured spatial hypergraph of a real city, connected to semantic and operational data layers.
>
> Scale morphisms operational from building component → district → city-wide strategy.
>
> Robots acted as agents executing decisions within the world model — an early closed-loop execution prototype.

M³C Component	Mapping in this World Model
H (Hypergraph)	Buildings, infrastructure, roads, trees as nodes; operational and spatial relationships as hyperedges
M (Multimodal)	Physical model + AR overlays + robot speech + database readouts
S (Scale)	Component → building → campus → city district
D (Dynamics)	Live database updates; robot navigation state transitions
C (Causal)	Visitor interaction triggering AR content; robot routing decisions

Project videos: Project video | Making-of video

F.2 EDP Picote Dam — Operational Decision Theater

DOMAIN	Infrastructure Digital Twin · Project Management · Decision Support · Risk Visualization



EDP Picote Dam: AR-enhanced operational view showing real-time project status and construction state.

What Was Built

- 3D representations of a dam — external and internal operational views
- Data-driven status indicators ("traffic lights") for construction schedule
- Real-time project management data integrated spatially
- Visual simulation of progress, risk status, and construction milestones

Why This is a World Model

This was an operational digital twin for infrastructure management. The 3D terrain and infrastructure representation served as a persistent spatial substrate onto which real-time project management data was layered. Decision-support logic operated over the model, enabling managers to understand at a glance the state of complex, multi-phase construction — a direct predecessor to what YVision now formalises as the Dynamics (D) and Causal (C) layers of the M³C kernel.

> M³C Classification: Infrastructure operational digital twin — explicitly demonstrates decision-support logic
>
> operating over a real-time updated spatial world model.

M³C Component	Mapping in this World Model
H (Hypergraph)	Dam structures, turbines, pipes, construction phases as nodes; dependencies as hyperedges
M (Multimodal)	3D model + numerical status indicators + traffic light overlays + textual annotations
S (Scale)	Component → structural section → full dam → project portfolio
D (Dynamics)	Real-time construction progress data; schedule vs. actuals tracking
C (Causal)	Decision logic: which delays trigger which risks; intervention triggers

F.3 Olympic Park Rio — VR Exploration of Future Territory

DOMAIN Urban Planning · Predictive World Modeling · VR · Stakeholder Communication

Olympic Park Rio: virtual reality model of a future urban territory, enabling spatial reasoning and stakeholder planning before construction.

What Was Built

- A full virtual reality model of a yet-to-be-constructed Olympic Park
- Exploration and navigation tools within the simulated future configuration
- Future-state spatial simulation for stakeholder communication and planning

A predictive world model. Project video

This project demonstrates predictive world modeling at urban scale — the construction of a M³C World Model not of what exists, but of what will exist. The model supported spatial reasoning and stakeholder communication across scales from individual venue to site-wide transport flows. It was a counterfactual world model: a causal representation of a future configuration whose interventions — construction sequences, venue placement — could be explored before commitment.

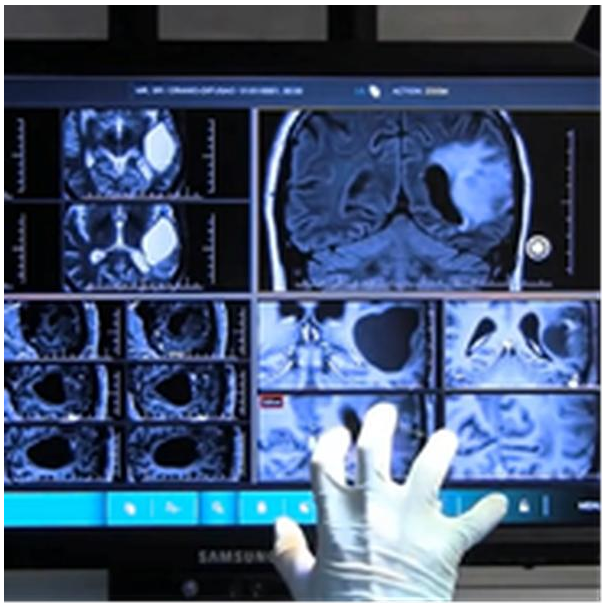
> M³C Classification: Predictive / counterfactual world model. Demonstrates the C-layer (causal intervention)
>
> applied to urban planning: 'What if we place the velodrome here instead of there?'

M³C Component	Mapping in this World Model
H (Hypergraph)	Future venues, transport nodes, public spaces, infrastructure as nodes; flow relationships as hyperedges
M (Multimodal)	3D geometry + symbolic labelling + spatial data overlays + VR immersion
S (Scale)	Individual venue → cluster → Olympic park → city transport network
D (Dynamics)	Construction phase sequencing; crowd flow simulation
C (Causal)	Design choice interventions: venue placement, access routes, capacity allocations

Project video: Olympic Park Rio VR

F.4 YScope — Surgical AR World Model

DOMAIN	Medical Digital Twin · Surgical AR · Anatomy Modeling · Real-Time Interaction



YScope: gesture-controlled AR interface for real-time interaction with patient imaging in operative contexts.

What Was Built

- Augmented Reality representations of patient medical imaging (CT, MRI)
- Gesture-based natural interface for navigation and manipulation
- Real-time interaction in operating room contexts
- Multi-layer exploration combining imaging modalities with surgical context

Why This is a World Model

YScope is a medical digital twin operating in real time. It builds a 3D reconstruction of anatomy from imaging data, binds that representation to physical spatial coordinates, and enables natural interface manipulation — precisely the multimodal, multiscale structure the M³C kernel formalises. The gesture interface acts as the agentic layer: the surgeon interacts with the world model to inform surgical decision-making. This project anticipates the YVision Health vertical by over a decade.

> M³C Classification: Medical digital twin — a real-time operational world model of a patient's anatomy.
>
> Demonstrates the M-layer (multimodal: MRI + spatial coordinates + gesture interface) and the S-layer (cell → tissue → organ).

M³C Component	Mapping in this World Model
H (Hypergraph)	Organs, vessels, tissue planes as nodes; proximity and flow dependencies as hyperedges
M (Multimodal)	CT/MRI imaging + 3D reconstruction + gesture input + visual overlay

M³C Component	Mapping in this World Model
S (Scale)	Cellular → tissue → organ → patient system
D (Dynamics)	Real-time imaging update; intraoperative anatomy changes
C (Causal)	Surgeon interventions: do(incise at position x); consequence modelling

Project video: YScope demonstration

F.5 RealSim — Virtual Car Racing Against Real Cars

DOMAIN Mixed Reality · Sports Simulation · Scene Modeling · Geometric Alignment

RealSim: virtual racing cars inserted into live race footage with real-time geometric alignment and collision logic.

What Was Built

- Real-time insertion of virtual racing cars into live race footage
- Geometric alignment of virtual objects with real-world perspective
- Collision logic for virtual-only interactions within real scenes
- Dynamic tracking of real cars to maintain spatial consistency

Why This is a World Model

RealSim required constructing a live world model of a real racing environment from video — extracting scene geometry, perspective, lighting, and object trajectories in real time, then inserting

virtual objects that obeyed the same spatial laws. This is mixed reality world synchronisation: maintaining coherence between a real physical world and a virtual one by operating on a shared world model representation. It directly prefigures the IDEAS video-to-world-model pipeline.

> M³C Classification: Mixed-reality world model with real-time scene modeling and virtual-physical coherence.
>
> Directly anticipates the IDEAS engine: video → scene graph → entity tracking → causal interaction.

M³C Component	Mapping in this World Model
H (Hypergraph)	Real cars, virtual cars, track, spatial zones as nodes; proximity and overtaking relationships
M (Multimodal)	Video stream + geometric model + physics engine + symbolic race state
S (Scale)	Vehicle position → track sector → full circuit → race strategy
D (Dynamics)	Real-time car trajectory tracking; virtual car physics simulation
C (Causal)	Virtual car placement decisions; collision avoidance logic

Project videos: Video 1 | Video 2 | Video 3

F.6 Environmental Installations — Ecosystem Micro-World Models

DOMAIN Ecological Simulation · Interactive Environments · Sensor Integration · Artificial Life

Left: LEGO Aquarium — interactive ecosystem with simulated fish behaviour and sensor integration. Right: Oceanarium Sea Monsters — AR creature exploration with encyclopaedic overlays.

What Was Built

- Modelled artificial ecosystems with simulated organism behaviour
- Artificial fish and sea creature agents responding to visitor interaction
- Interaction zones mapped and sensor-connected to virtual representations
- Encyclopaedic content layered over physical creature displays

Why These Are World Models

These installations were micro-world models: domain-specific, spatially grounded representations of ecological systems with dynamic, agent-driven behaviour. The LEGO Aquarium modelled an underwater ecosystem in which artificial agents exhibited behavioural rules responding to physical interaction. The Oceanarium Sea Monsters project layered semantic information over physical exhibits, creating a multimodal world model of a natural history collection. Both demonstrated that world models can integrate physical environments as part of the representational substrate — a key principle behind the Internet of Nature architecture.

M³C Classification: Ecological micro-world models with embodied agents and sensor-physical integration.

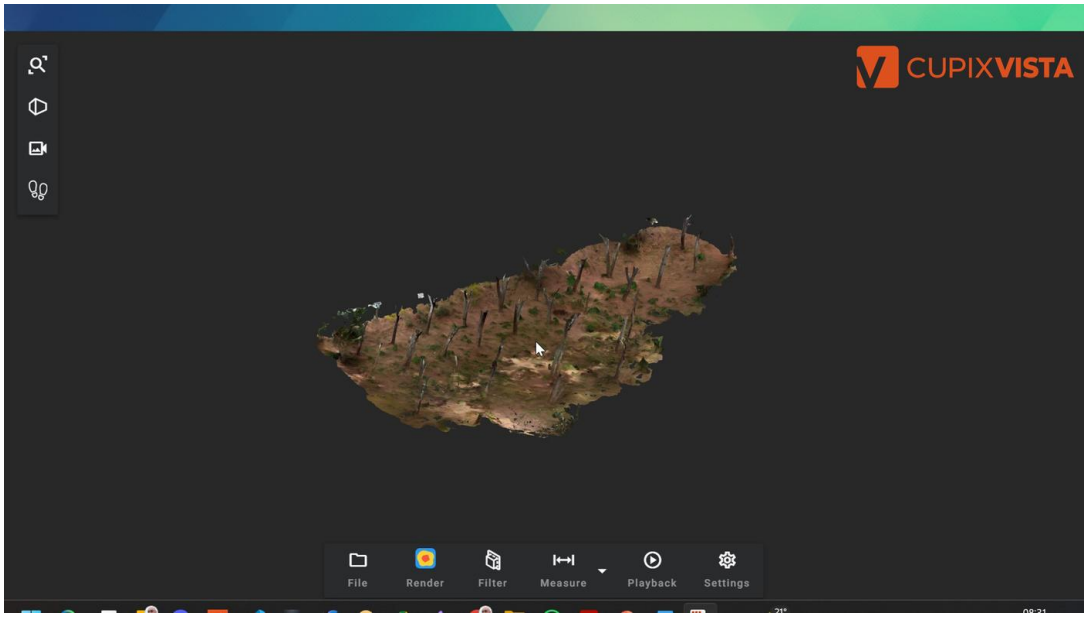
Anticipates the Internet of Nature architecture: real-physical space + sensors + agent behaviour + semantic overlay.

M³C Component	Mapping in this World Model
H (Hypergraph)	Species, habitat zones, interaction points as nodes; predation and proximity as hyperedges
M (Multimodal)	Physical exhibits + AR overlays + sensor input + encyclopaedic text + visitor interaction
S (Scale)	Individual creature → species population → ecosystem → habitat zone
D (Dynamics)	Agent behaviour rules; visitor-triggered state changes
C (Causal)	Visitor interaction interventions; species interaction rules

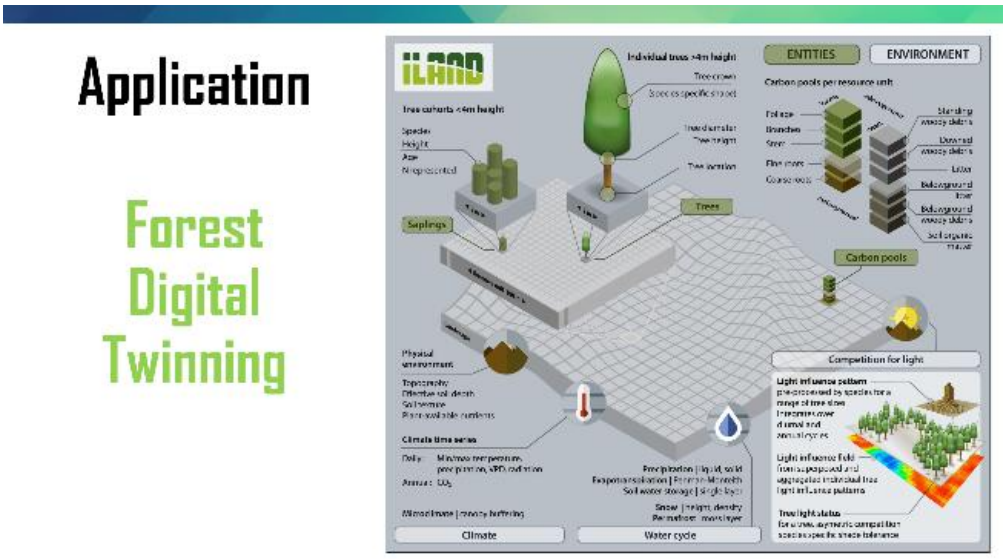
Project videos: LEGO Aquarium | Oceanarium Sea Monsters

F.7 Internet of Nature Worlds and Agents

DOMAIN Ecological AI · Forest Digital Twin · Nature Agents · IoN Operational Platform



Forest digital twin generated via CupixVista photogrammetry: a real post-fire forest reconstructed as a manipulable 3D world model.



iLand forest digital twinning application: multiscale forest model with individual tree entities, carbon pool tracking, climate dynamics, and species competition modelling.

What Is Being Built

The Internet of Nature Worlds and Agents represents the current frontier of YVision's world model programme — the evolution from deployed prototypes to a sovereign, planetary-scale ecological operating system. Two strands illustrate this:

Strand A: Photogrammetric Forest Twins

Using tools such as CupixVista and drone-based photogrammetry, real forest territories — including post-fire recovery zones in Portugal — are being reconstructed as high-resolution 3D world models. These twins capture individual tree positions, canopy structure, terrain morphology, and ground cover, providing the spatial hypergraph substrate (H) of the M³C kernel. This is the foundation of the Nature Capability extraction pipeline: from physical forest to measurable, simulatable digital representation.

Strand B: Agent-Based Ecological Simulation (iLand)

The iLand forest simulation framework demonstrates the full M³C architecture applied to ecological systems. Individual tree entities are modelled with species-specific attributes — height, crown, wood type, carbon pool — subject to climate dynamics, light competition rules, and water cycle coupling. This is a working M³C World Model instantiation: entities and hyperedges (H), multimodal data layers (M), scale morphisms from individual trees to carbon sequestration totals (S), seasonal dynamics (D), and causal intervention operators for thinning and species management (C).

> M³C Classification: Full M³C World Model implementation — the most complete instantiation in the YVision portfolio.

Demonstrates all five tuple components (H, M, S, D, C) operating simultaneously in an ecological domain.

Direct implementation target for the PNCC / Internet of Nature sovereign deployment.

M³C Component	Mapping in this World Model
H (Hypergraph)	Individual trees, species, soil patches, water bodies, climate cells as nodes; competition, nutrient flow, and predation as hyperedges
M (Multimodal)	Photogrammetric 3D models + satellite imagery + LiDAR + drone video + climate time series + acoustic sensors
S (Scale)	Individual tree → stand → forest → watershed → national carbon balance
D (Dynamics)	Growth cycles, succession dynamics, fire propagation, climate drift, species migration
C (Causal)	do(thinning_pattern) → fire risk; do(species_introduction) → biodiversity; do(irrigation) → soil moisture

Interactive model under development: A Desirable Worlds and Agent List

F.8 Synthesis: The YVision World Model Lineage

Taken together, the seven project classes documented in this appendix constitute a 25-year empirical record of world model construction across domains. Each deployment tested a different aspect of what the M³C formalism now unifies:

Project	Domain	H	M	S	D	C
Santander Financial City	Urban/Corporate	✓	✓	✓	✓	✓
EDP Picote Dam	Infrastructure	✓	✓	✓	✓	✓
Olympic Park Rio	Urban Planning	✓	✓	✓	✓	✓
YScope	Medical	✓	✓	✓	✓	✓
RealSim	Sports / MR	✓	✓	✓	✓	~
Environmental Installs	Ecology	✓	✓	✓	✓	~
IoN Worlds & Agents	Nature / IoN	✓	✓	✓	✓	✓

The consistent presence of all five M³C components — even in the earliest deployments — confirms that YVision was not building isolated applications, but iteratively constructing a world model operating system. The Internet of Nature Worlds and Agents initiative brings this lineage to its natural culmination: a sovereign, planetary-scale, causally manipulable world model of natural capital, built on 25 years of operational precedent.

> This appendix demonstrates that YVision is an evolution, not a hypothesis. Every claim in the white paper
>
> about M³C-WM architecture, agentic orchestration, multimodal integration, and closed-loop execution
>
> has a direct precedent in a real, deployed system documented here.