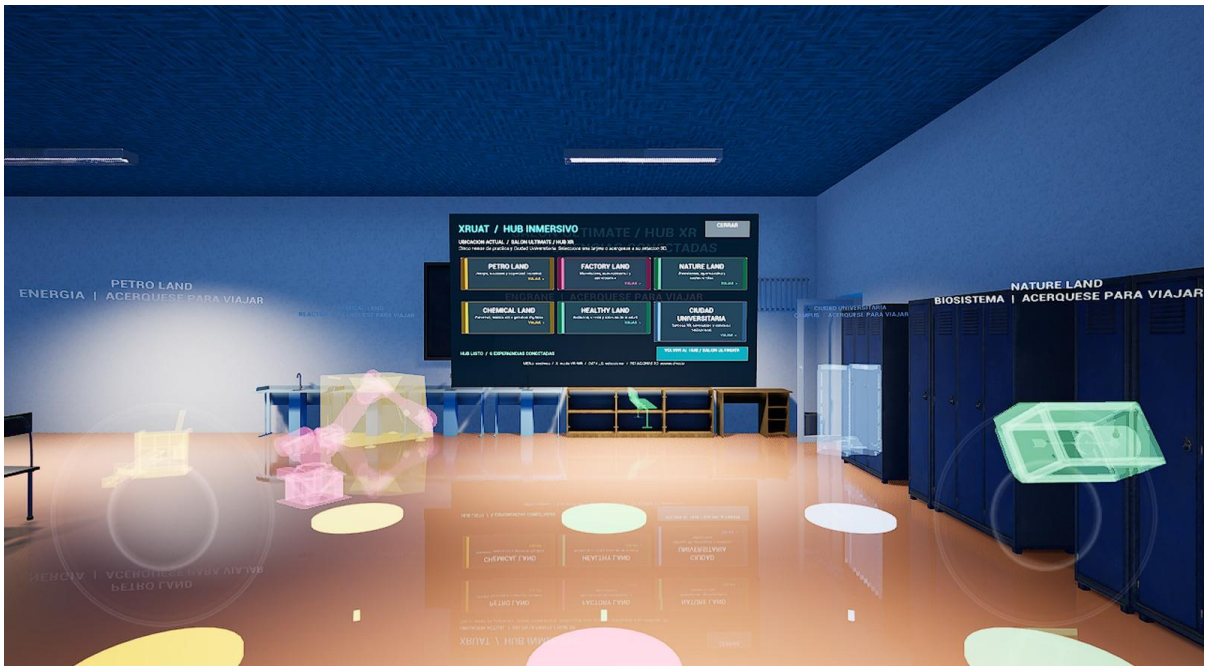
Universidad Autónoma de TAMAULIPAS

Unidad Académica Multidisciplinaria Reynosa-AZTLÁN

XR-UAT

INNOVATION · FINAL JUDGE SUBMISSION

One learning architecture across six realms, machine-specific interfaces, immersive modes and supervised experiment practices



Current XR-UAT evidence from the Unreal Engine ecosystem. Figures are labelled as native captures, documentary records or explanatory diagrams.

QS Reimagine Education Awards 2026

Immersive Experiential Learning · Academic – Early Stage · Scalability pathway

Universidad Autónoma de Tamaulipas · UAM Reynosa-Aztlán · México

Evidence reviewed through 10 August 2026

1. Direct responses to the QS Innovation questions

The answers are written for direct use in the scored form. The following pages substantiate every material claim.

Q1. QS criterion response

What specific aspects of your project are genuinely innovative compared to existing solutions, practices, or approaches in this space?

XR-UAT's innovation is not just the isolated use of virtual reality, augmented reality, digital twins, artificial intelligence or MQTT. It is the educational environment created among them. From the Salon_Ultimate hub, learners enter six connected realms—Petro Land, Factory Land, Nature Land, Chemical Land, Healthy Land and Digital Land—and follow the sequence: inspect, rehearse, interpret, decide, document and transfer before or alongside supervised real-world experiment practice.

The current Unreal Engine implementation separates domain content from a reusable machine contract. A configured asset can expose identity, permitted actions, variables, units, limits, source quality and machine-specific MQTT topics through a common HMI grammar. In Chemical Land, fractional distillation and polymerization now use dashboards with operational controls: monitoring, analysis, configuration, mapping and help. Digital Land contains SARA, the contextual AR assistance application. The website has a browser route easy to follow, judges can explore the 3D Separation Processes Laboratory and digital-twin dashboard that explicitly labels telemetry as simulated until an authorised MQTT connection is made.

This design turns immersive content into a learning platform. Desktop and VR provide current access routes; onsite MR is subject to compatible passthrough and permission; the Insta360 remote-MR route is an integration pathway within Digital Land and is not reported as accepted hardware evidence. Instructor guides, rubrics, evidence templates and visible data keep the learner's reasoning—not the technology—at the center. The innovation lies in connecting six disciplinary contexts, reusable technical services, multimodal delivery and auditable decisions without rebuilding every activity as a standalone experience.

Length check: within the 300-word limit

1. Direct responses to the QS Innovation questions · continued

Q2. QS criterion response

Provide examples of comparable initiatives, solutions, or approaches, and explain how your project differs from or improves upon them.

PhET demonstrates the value of research-based interactive exploration, while OLabs combines theory, procedures, animation, video and online experimentation. Commercial virtual-laboratory platforms such as Labster and PraxiLabs emphasize repeatable simulated laboratory experience. Industrial digital-twin demonstrators provide telemetry and operational realism, and standalone VR or AR applications provide presence or contextual guidance.

XR-UAT has these strengths but addresses a different integration problem. It is neither a library of random simulations nor a single virtual laboratory. Six realms are connected through one hub and one learning sequence. A data-driven machine catalogue and canonical HMI preserve the meaning of identity, actions, variables, limits, monitoring, analysis and source quality while allowing each machine to retain discipline-specific parameters. An MQTT connection to physical equipment is not required to use XR-UAT. When MQTT is enabled, XR-UAT operates it under controlled conditions and clearly distinguishes simulated, stale and offline states from live data received through an authorized connection. The public browser route makes the Separation Processes Laboratory and its 3D assets inspectable without a headset; it has access and interface behavior, not an unverified connection to a physical device. Digital Land houses SARA and the integrated remote-MR presentation path; accepted live-camera and device performance remain separately verified.

Most importantly, XR-UAT connects digital activity to curriculum, supervised physical work and an auditable evidence packet. Learners inspect, act, interpret, justify and transfer; instructors receive guides, rubrics, technical checklists and data templates. Its improvement is architectural and pedagogical: it unifies context, machine state, modality, data provenance, assessment and transfer across heterogeneous engineering practices while remaining locally owned and extensible by the university.

Length check: within the 300-word limit

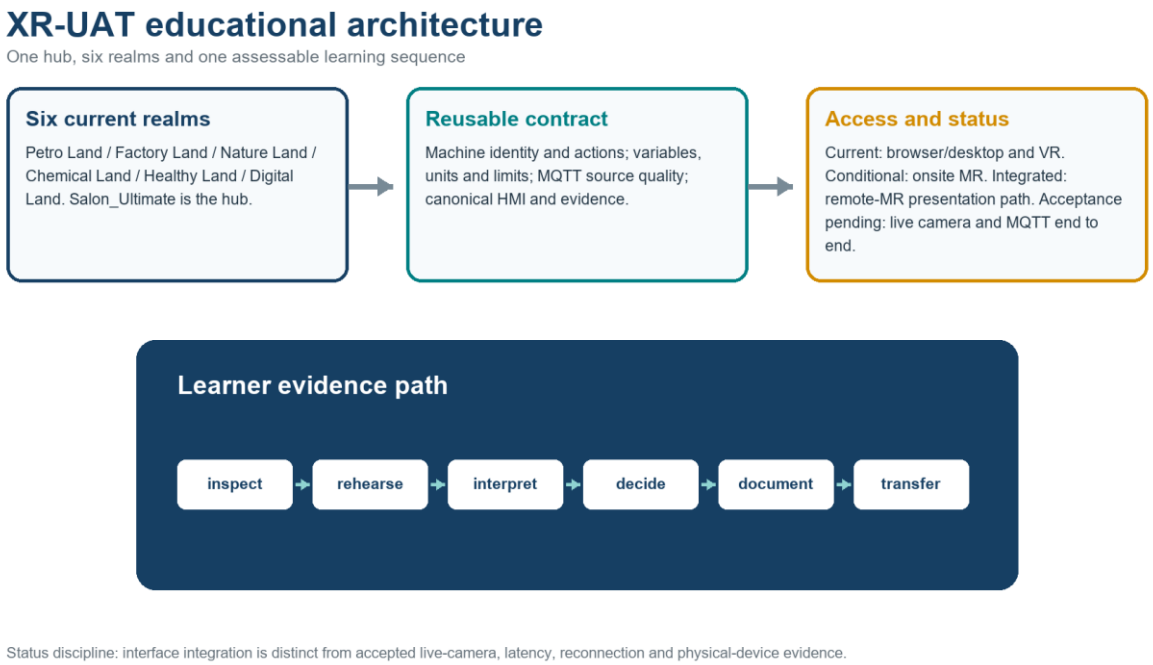
2. The educational design problem

Engineering learners frequently reach costly, complex or safety-sensitive equipment with strong theoretical preparation but limited opportunity to diagnose errors. XR-UAT relocates selected cognitive work—orientation, procedure rehearsal, variable interpretation and error recognition—to an immersive preparation stage. Supervised physical practice remains the destination where equipment, authorization and safety conditions permit it.

The learning sequence is: inspect, rehearse, interpret, decide, document and transfer. That sequence is more important than the headset, it turns each environment into an opportunity for the learner to use its reasoning.

Design requirement	XR-UAT response
Safe repetition	Repeat procedures and recover from errors before scarce real-world laboratory time.
Operational reasoning	Require learners to interpret variables, limits and data quality before acting.
Continuity	Has one decision pathway across current desktop/VR, conditional onsite MR and the remote-MR route.
Assessment	Pair practices with guides, rubrics, technical logs and transfer tasks.

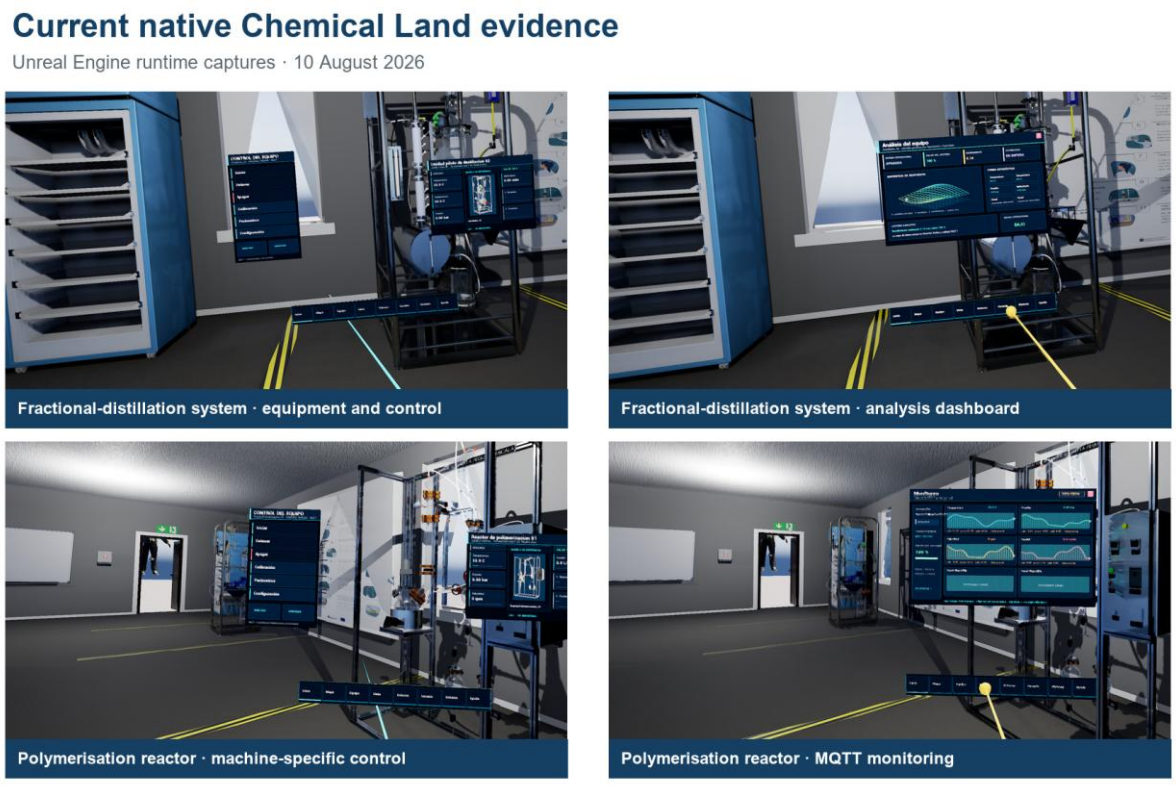
3. Six realms, one governed ecosystem



Explanatory architecture diagram. Salon_Ultimate is the hub for Petro Land, Factory Land, Nature Land, Chemical Land, Healthy Land and Digital Land; it is not another laboratory.

The realms provide disciplinary context while shared services preserve navigation, machine-state conventions, presentation profiles and evidence logic. A realm is claimed only at the level supported by its current module, practice and records. This distinction allows the system to grow without transforming every experimental scene into a separate platform.

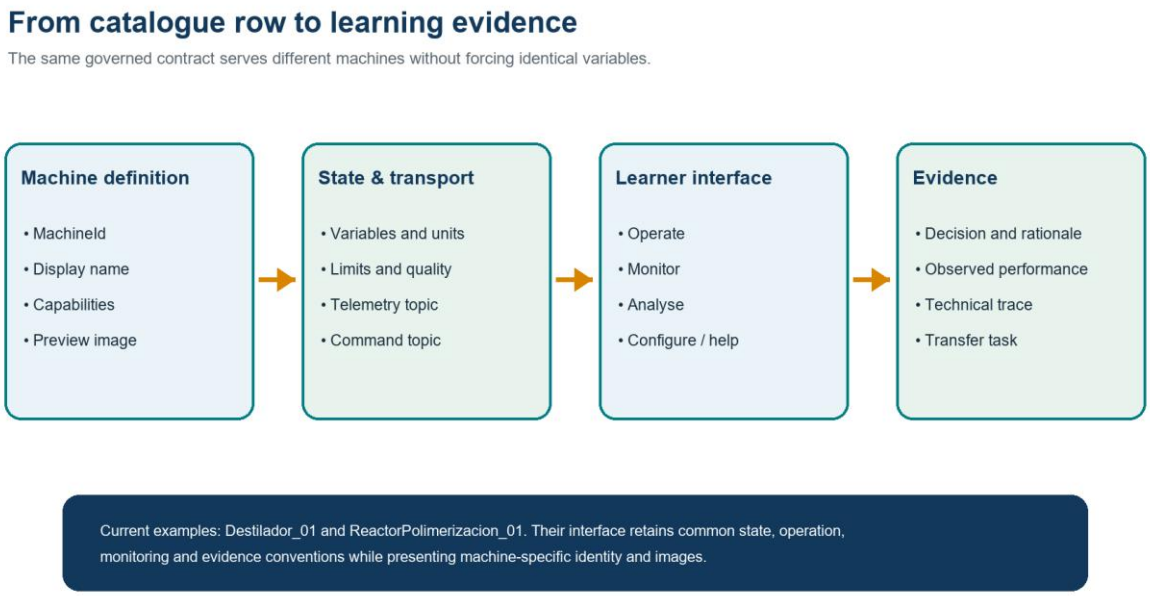
4. Current Chemical Land: machine-specific evidence



Native Unreal Engine runtime captures. The fractional-distillation system and polymerization reactor use the current machine-specific interface, including analysis, monitoring and MQTT configuration. The close distillation capture was taken at the mapped equipment position; its background is not presented as a physical-laboratory interior.

These screens are not graphic reconstructions. The loaded project maps Destilador_01 to a fractional-distillation preview and ReactorPolimerizacion_01 to an agitated-reactor preview. Both retain the same interface grammar—identity, operations, monitoring, analysis, configuration, map and help—while presenting machine-specific content. The learner therefore changes engineering context without relearning the meaning of state or evidence.

5. Reusable machine contract and HMI



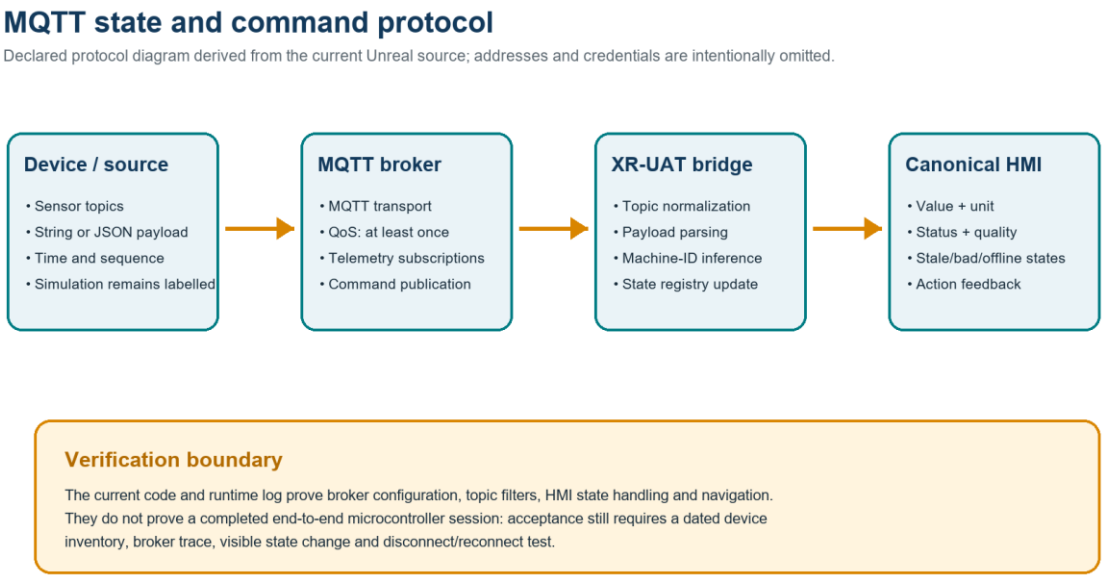
Explanatory diagram derived from the current catalogue, HMI and evidence workflow; it is not an Unreal Blueprint capture.

A configured machine is treated as more than a 3D model. Its catalogue row links identity, supported actions, variables, limits, capability flags and a preview image. At runtime the HMI uses that contract to show what the equipment is, which actions are permitted, what the available values mean and whether the source can be trusted. This design supports reuse without erasing discipline-specific decisions.

The current implementation derives machine-specific topic pairs in the form xruat/<MachineId>/telemetry and xruat/<MachineId>/command. Topic identity, displayed machine identity and evidence identity can therefore remain aligned.

Public route at: https://xr-uat.com.mx/?lang=en makes this architecture inspectable outside Unreal. Its browser-based Separation Processes Laboratory exposes the complete 3D layout and individual assets, while the operations dashboard identifies demonstration telemetry and offers an optional authorized MQTT-over-WebSocket connection. The web route proves public accessibility, 3D interaction and transparent state labelling; it is not presented as a dated end-to-end physical-device acceptance record.

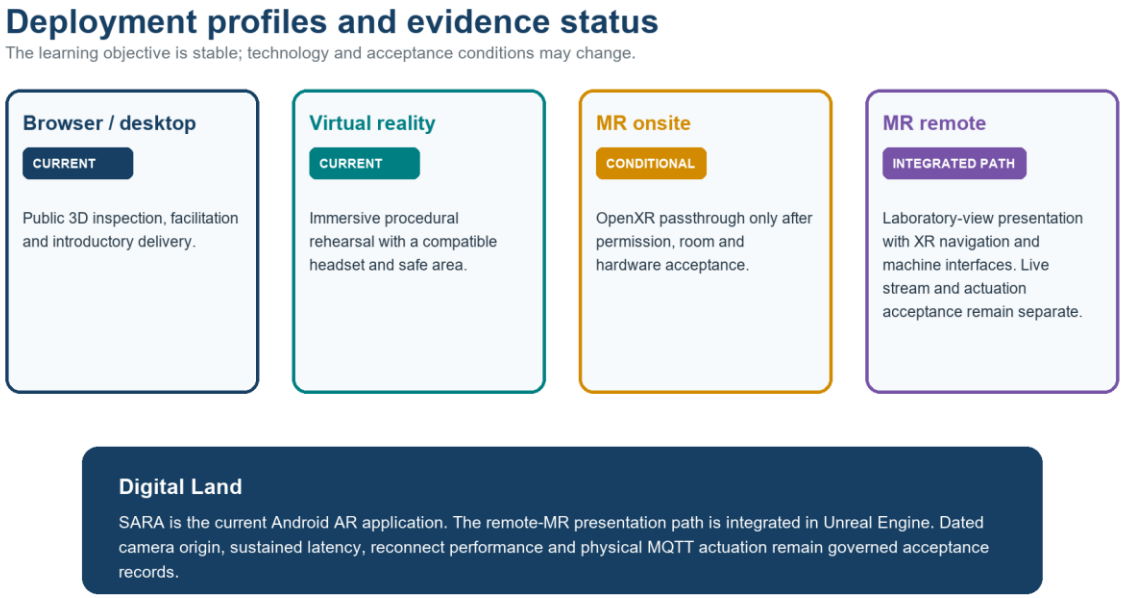
6. MQTT, mixed reality and data provenance



Explanatory MQTT diagram derived from the implemented bridge and machine-action path. Addresses and credentials are omitted; the diagram is not presented as live-device acceptance evidence.

MQTT is an optional transport layer for authorized hardware or laboratory systems. The current code supports subscriptions, payload parsing, machine-specific command publication and explicit connection or staleness states. Missing connectivity is not converted into plausible telemetry. That choice teaches a foundational engineering rule: establish source and quality before interpreting a number.

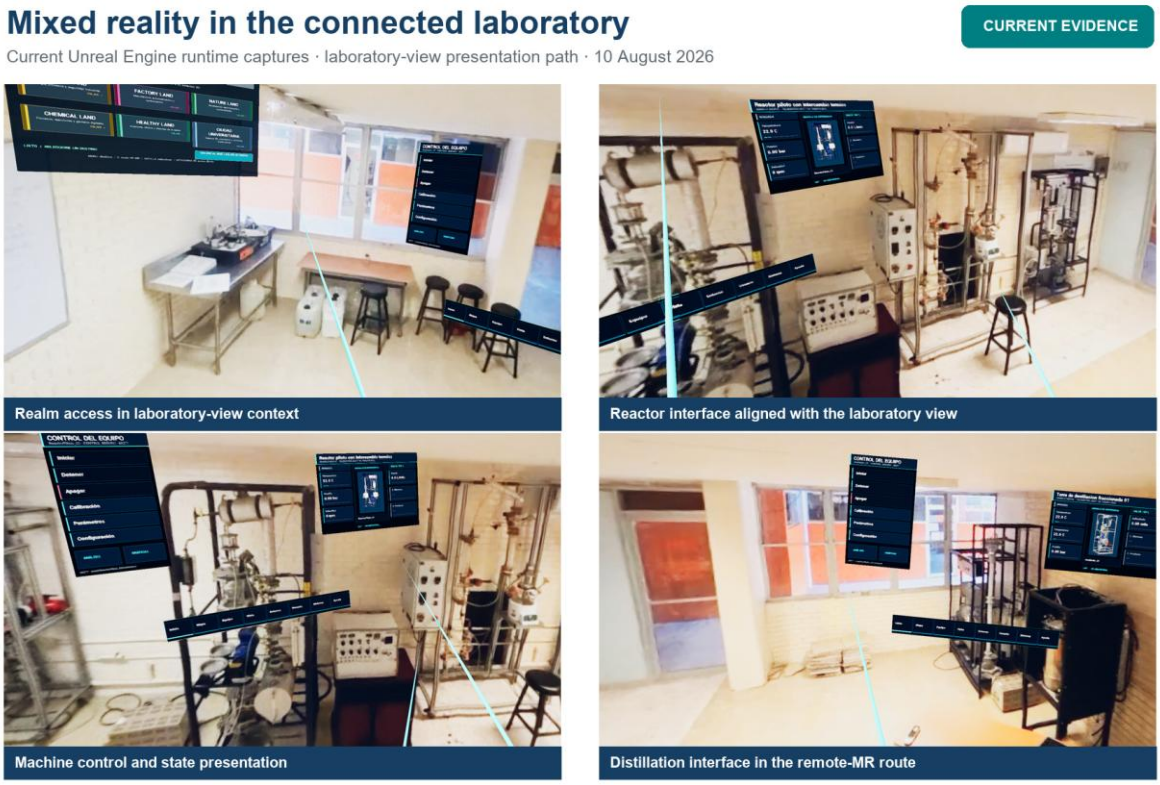
6. Mixed reality and delivery profiles · continued



Explanatory delivery-profile diagram. Desktop and VR are current access routes. Onsite MR remains conditional on compatible passthrough and permission. The current runtime captures on the following page document the remote-MR presentation path; accepted live-camera latency, reconnection and device actuation remain separately verified conditions.

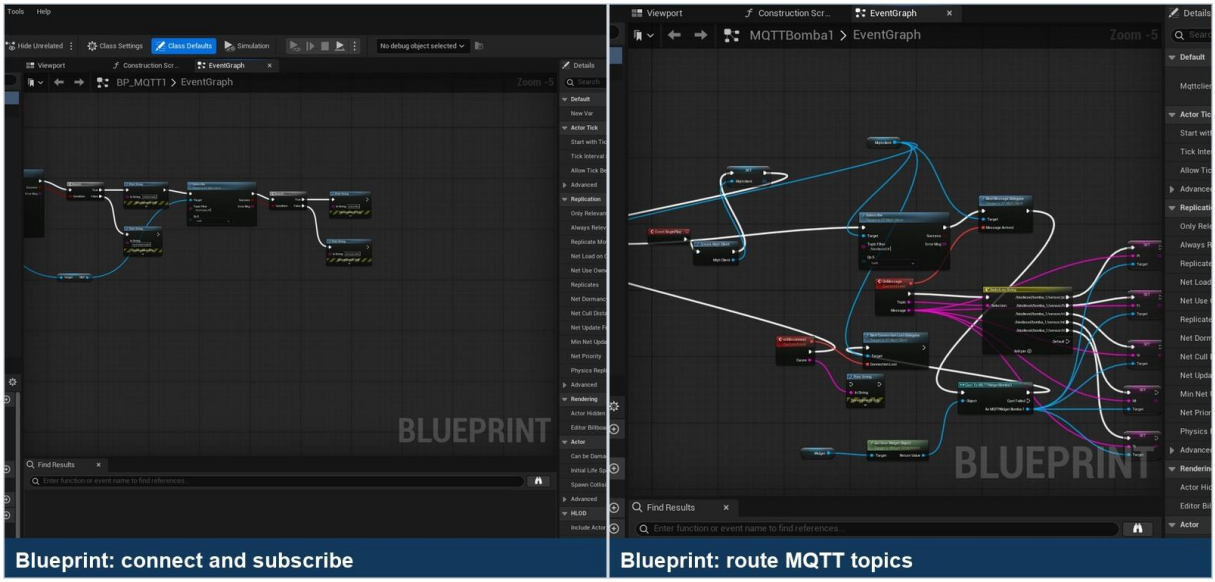
Onsite MR depends on compatible OpenXR passthrough and explicit runtime permission. Digital Land is the home of SARA and the Insta360 remote-MR presentation route. The current runtime captures show a laboratory-view background combined in Unreal Engine with XR-UAT realm access, shared navigation, machine controls and machine-specific state panels. They are valid evidence of the integrated presentation path; they do not, by themselves, establish the camera source, sustained latency, reconnect performance or live MQTT actuation. Those claims require a dated device inventory, stream and broker trace, visible state change, and disconnect/reconnect test.

6. Mixed reality runtime evidence · current capture set



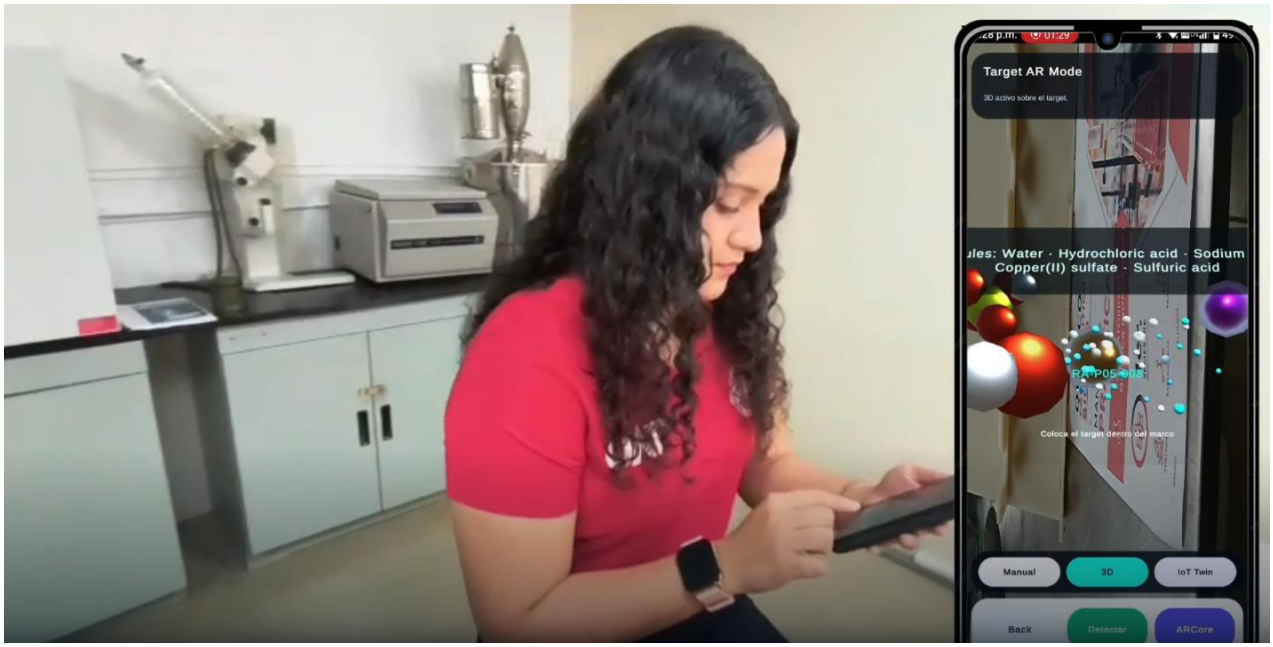
Native Unreal Engine runtime captures. The laboratory view is combined with XR-UAT navigation, equipment control and machine-specific state interfaces. The figure demonstrates the integrated remote-MR presentation path; live-camera origin, sustained latency, reconnect performance and physical MQTT actuation are governed by separate acceptance records.

7. Native Blueprint and SARA evidence



Native Unreal Blueprint captures showing MQTT connection/subscription and topic-routing logic. These retain the original node colours and graph layout.

The Blueprint graphs and current C++ framework provide complementary evidence: graphs expose the interaction path, while the framework makes the machine catalogue, state handling and interface reusable.



SARA evidence: a real-use frame and the Android augmented-reality interface associated with XR-UAT's digital-content layer.

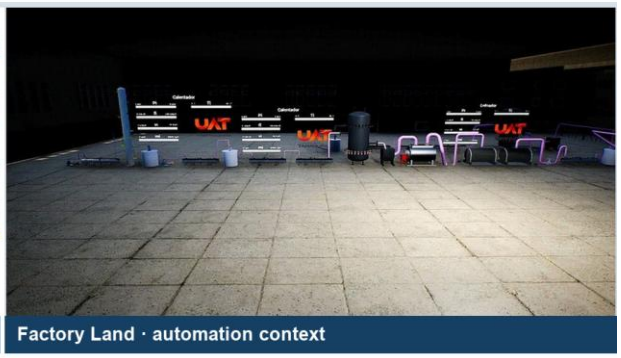
SARA is the current augmented-reality application within Digital Land. It supplies contextual assistance from a prepared visual target. It can support orientation or interpretation at the point of activity, but it does not replace instructor oversight, learner reasoning or scored assessment.

8. A connected family of engineering practices


Petro Land · well operations


Petro Land · refinery operations


Chemical Land · fractional distillation


Factory Land · automation context

Representative current modules: Petro Land well operations and refinery operations, Chemical Land fractional distillation, and Factory Land automation. Images are native project evidence, not stock photography.

Pozo 08 is the lead module for procedural rehearsal, coupling, hazard recognition and supervised transfer. Petro Land refinery operations develop process line-up and safe start-up reasoning. Chemical Land fractional distillation requires system tracing, source verification and variable interpretation. Factory Land supplies the automation context. The realms provide breadth; the formalized practice packets show how different experiential activities preserve the same inspect–rehearse–interpret–decide–document–transfer sequence.

9. Comparative position

Reference	Established strength	XR-UAT contribution
PhET	Research-based, accessible conceptual exploration	Adds immersive industrial context, machine-state conventions, evidence capture and supervised transfer.
OLabs	Theory, procedure, animation, video and online experimentation	Extends the workflow across six realms, multimodal delivery and configurable machine/data contracts.
Virtual-lab platforms	Repeatable simulated procedures	Connects procedures to data quality, current HMI state, local curriculum and physical-practice preparation.
Industrial digital twins	Telemetry and operational representation	Turns provenance and operational decisions into assessed educational evidence.
Standalone VR/AR	Presence or contextual guidance	Coordinates browser/desktop, VR, conditional onsite MR, the integrated remote-MR presentation path and SARA without changing the learning objective.

Comparator sources reviewed: PhET About (phet.colorado.edu/translation/27/about) and OLabs About/For Teachers (olabs.edu.in). Product categories are used to establish the field; the submission does not claim that competitors lack every individual feature.

10. Evidence chain and claim boundaries

Claim	Evidence	Interpretation boundary
Six connected realms	Current hub/menu source and runtime view	Does not imply equal maturity in every realm.
Machine-specific HMI	Current distiller/reactor native captures and source mapping	Interface evidence is distinct from physical-device acceptance.
MQTT capability	Blueprints, C++ bridge, topic derivation and configuration screen	Live telemetry requires a dated end-to-end trace.
Multimodal delivery	Mode subsystem, selector and validation protocols	Current MR captures establish interface integration; passthrough and accepted live-camera/network performance require separate acceptance.
Educational integration	Practice packets, curricular records and assessment instruments	Outcome effects are reported separately in the Impact submission.

Language and evidence convention

Institutional records issued in Spanish remain the originals. English titles, captions and summaries in this submission are faithful translations. Photographs prove that an activity took place; learning and reach claims are made only from countable records and assessment files.

Innovation conclusion

XR-UAT is a coherent educational architecture: six contextual realms, a reusable machine and HMI contract, explicit data provenance, multimodal access and a common evidence pathway. Its innovation lies in preserving the learner's decision process across technologies and engineering contexts, rather than presenting technology as the outcome.