Immersive Technologies

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3. Increasing AI-enhanced user experience
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Introduction

Immersive technologies create simulated experiences for users where the boundary between the virtual and physical worlds blurs. Examples of these technologies include virtual reality (VR), augmented reality (AR), and mixed reality (MR). It also encompasses concepts like 360-degree video, spatial audio, and interfaces that provide haptic (touch-based) feedback. Extended reality (XR) is mainly an umbrella term for VR, AR, and MR, and in this chapter, the term immersive technologies is used interchangeably.

Immersive technologies have progressed over the last decade due to advancements in computation and AI. This development has led to more mature functionalities from the user perspective (like better user-friendliness and higher levels of experience), and best practices have transitioned to real-world uses (see also SURF Tech Trends 2023 and XR trend update 2024). Organisations across societal domains and industries are recognising where immersive experiences (IX) can add value. Currently, the focus is on technologies tailored to address real-world practical challenges and training individuals for real-life scenarios.

The technological focus regarding the development of immersive technologies and their XR applications is shifting. Until recently, the focus was on hardware innovations that led to incremental gains in ergonomics, styling/elegance, miniaturisation, and display quality of VR/AR headsets and smart glasses. Gains in comfort and appearance have emerged as a decisive factor for users to (potentially) adopt these headsets and glasses, followed by affordability, functionality, and content.

Currently, the technological developments are moving to middleware infrastructures and platforms supporting the deployment of XR applications. These act as service layers for instructors and operational staff to create or adapt content without specialist support, and it could also include easy-to-use platforms (‘low coding’) to create immersive applications. It is expected that Generative AI (GenAI), virtual assistants, and other AI-based tools will further enhance the functionalities and content capabilities of immersive applications over the coming period.

The primary obstacle to general adoption of immersive technologies is not the technological capabilities of XR systems but rather change management within organisations: helping professionals like teachers, researchers, engineers, service technicians, police officers, or military personnel to embrace XR as an everyday tool rather than a lab curiosity or gaming device.

Contributors
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TREND #1

AR and smart glasses become more prominent

Public Values

Autonomy	Privacy
Justice	Inclusion | Equity | Transparency |
Humanity	Safety | Meaningful contact | Well-being

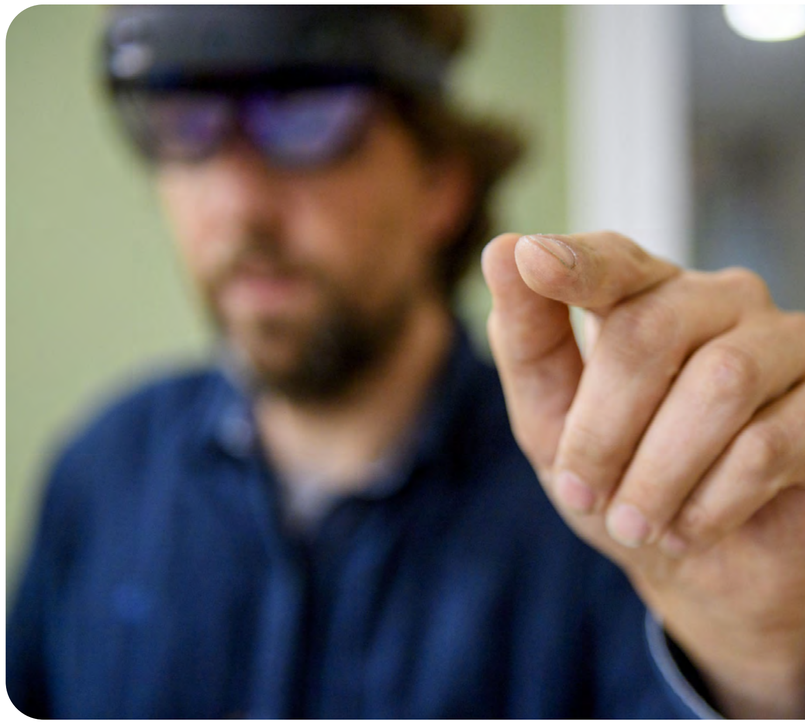
Maturity WATCH **PLAN** ACT

Drivers

Individualisation & empowerment; Automation & AI; Engineering advances & computation; Connectivity & interaction; Concentration of wealth & economic inequality

AR and smart glasses have faced adoption barriers in recent years due to bulky designs. Now, they are lighter, more comfortable, and resemble conventional eyewear. A broader range of products has targeted niche and general markets. Major companies like Apple, Meta, and Google are signalling imminent launches, thus indicating that smart glasses will become mainstream and more widely used. However, it is not expected that smart glasses will fully live up to their potential and become mainstream in the next 15 years. Till then, it is anticipated that AR and smart glasses will be developed mostly for specific use cases.

To date, several AR devices and smart glasses have been introduced into the market. While some glasses are still in the beta-testing phase, others are launched softly and in a controlled manner, for example on a country-by-country basis. However, key questions concerning functional added value, appearances, usability, and ethics will remain.



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Sales

Meta Ray-Ban glasses are selling well (2 million already, and production will vastly increase to 10 million per year) (uploadvr.com)

Promise by big tech companies

Google showing off their AR glasses at TED and call them "The next computer" (youtube.com)

Apple Working on smart glasses to beat Ray-Ban Meta, new report claims (forbes.com)

Acceptance perspectives

Perspectives on the acceptance and social implications of smart glasses (ris.utwente.nl)

New launches of products

HTC Vive Eagle (vive.com)

Meta's next-gen smart glass (hiverlab.com)

Product reviews & sneak peek demos (wired.com)

Amazon developing consumer AR glasses to rival Meta (reuters.com)

"AR glasses enable seamless assisted reality, allowing for researchers outside a lab to easily view and collaborate on physical lab tasks in real-time."

- **Remco de Jong**, CEO UnboundXR

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Education

- Faster skills transfer is foreseeable in practical lab settings based on for example augmented instructions.
- Augmented reality functionality of glasses assists in an easier wayfinding and provision of student information through the campus.
- Easier live caption of education & training activities for students and teachers with impaired vision or language barriers.
- Attention to the use of AR glasses within the classrooms, exam settings and communal areas, including the processing of biometric data may need a policy review.

Research

- Devices support through augmented reality and forms of user interaction, enhanced remote collaboration with research peers, such as lab team members.
- Easier accessibility of captured (live) data through smart glasses.
- Interaction with research information and communication related to open science.

Operations

- Smart glasses in combination with augmented reality and digital overlays support equipment installation, operations, and maintenance.
- Augmented reality functionality of glasses assists in an easier wayfinding for visitors through the campus.

TREND #2

Democratisation of XR content creation using generative AI

Public Values

Autonomy	Independence | Freedom of choice
Justice	Inclusion | Transparency
Humanity	Personal development

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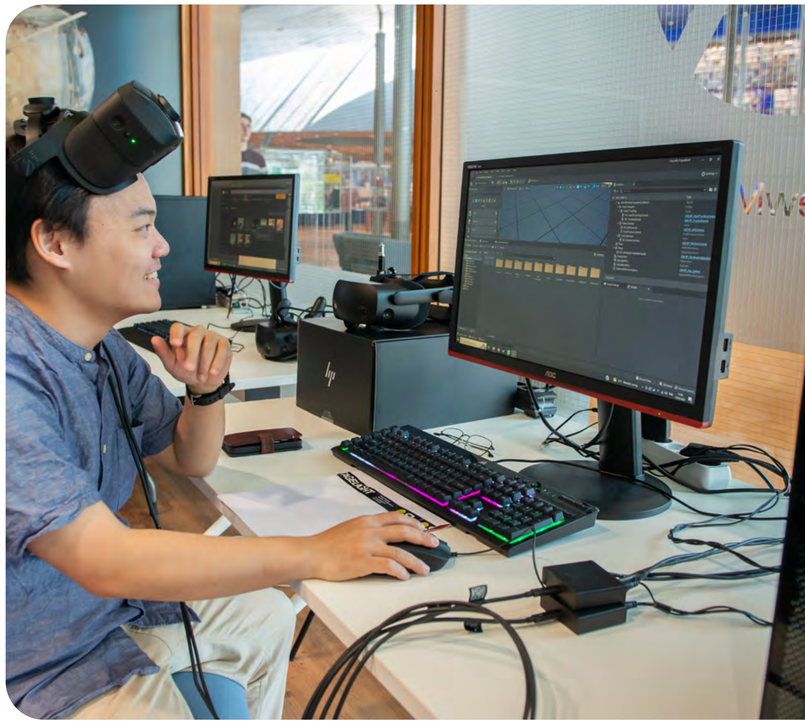
Drivers

Individualisation & empowerment; Value of knowledge & skills; Automation & AI; Energy supply & demand

Recently, GenAI and other AI-based tools have emerged to support XR, mainly VR, content creation. This development reshapes and democratises content creation by lowering technical barriers and costs and enabling faster development and deployment.

The tools empower actors, such as independent creators, enterprises, educators, and researchers, to prototype ideas and produce 3D-constructed assets and virtual worlds faster, more efficiently, and at scale, without extensive technical skills.

In other words, AI is facilitating low-code to no-code XR creations for everyone in the community. The adoption is gradual and use-case dependent. Challenges emerge surrounding copyright, content ownership, skill development in creative design and content creation, and excessive energy consumption.



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Platform integration

Major XR platforms are embedding generative AI directly into their toolchains lowering entry barriers:

Adobe Project Scenic builds and manipulates full 3D scenes from simple prompts, integrating seamlessly into creative workflows (theverge.com)

Unity 6 includes Generative AI Features for smart NPCs, real-time speech synthesis, and asset generation (unity.com)

Meta Horizon Worlds allows now to generate entire VR environments via AI prompts, lowering the barrier for social XR world-building (developers.meta.com)

Faster 3D asset creation with AI

Generative AI tools are significantly reducing time and effort required for 3D asset creation:

AI modelling tools can reduce 3D asset creation time by up to 70% for complex scenes (alpha3d.io)

Meta 3D AssetGen generates high-quality meshes with realistic texture and materials in under 30 seconds (assetgen.github.io)

"In the past, users without technical skills weren't able to do 3D creation on their own. Now, out of the blue, they have easy to use AI-based tools that help them do something without any 3D modelling experience."

- Keith Mellingen, VRINN

IMPACT

Education

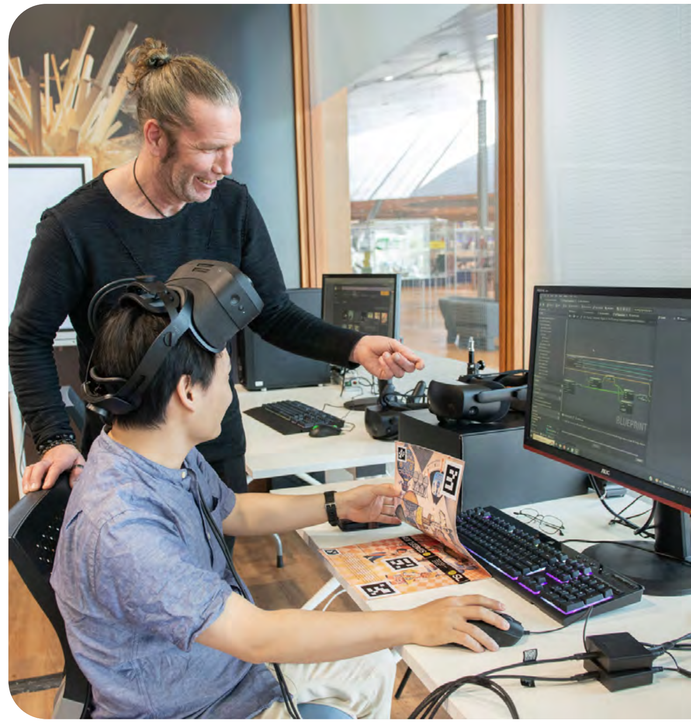
- The AI-XR convergence trend supports faster creation of bespoke XR learning environments once the visual fidelity performance is met by XR platforms and applications for education.
- Despite the low-code and no-code, teachers might still require assistance and support from experts and skilled professionals to guide students.

Research

The democratisation of AI-enabled XR content can support rapid prototyping of experimental XR-based setups and access to graphical and 3D-modelled assets for research.

Operations

- Lower production costs for simulations require high levels of functional validation (for example, safety-critical simulations).
- Facilitating platforms for creation and deployment of XR emerge.



TREND #3

Increasing AI-enhanced user experience

Public Values

Autonomy	Freedom of choice | Diversity
Justice	Inclusion
Humanity	Safety | Well-being | Personal development

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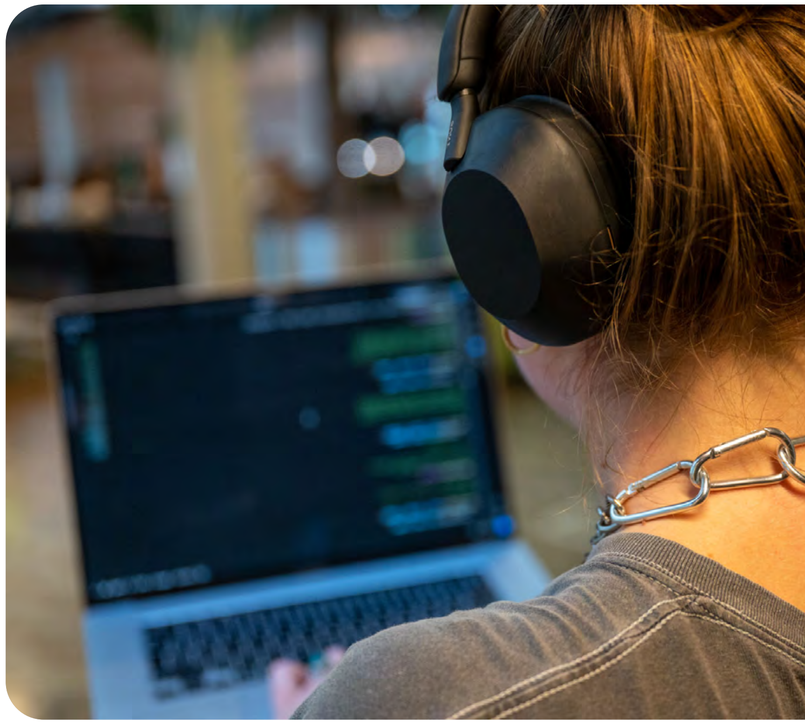
Drivers

Individualisation & empowerment; Community dynamics & social cohesion; Automation & AI; Connectivity & interaction

AI is enhancing the user experience in real-time by augmenting realism, context-aware interactivity, and personalisation. Predictive models, sensory input (eye tracking, voice recognition), and continuous data analysis enable XR systems to interpret human gaze, gestures, emotions, and spatial mapping in real time. Simultaneously, this adapts the immersive experience to the user without prompting.

Virtual assistants enhance engagement, while other AI-based engines optimise graphics performance and provide dynamic content and visual fidelity. Emerging technologies like brain-computer interfaces (BCIs) and neurotechnology could minimise physical efforts when using XR. This AI/XR convergence will lead to AI-enhanced XR that anticipates user needs and behaviours.



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Always-available, adaptive AI-agents

(Ai)Daptive XR platform empowers students and instructors to run fully immersive (qualcomm.com)

Digital identity convergence

Immersive Technology, blockchain and AI are converging (weforum.org)

AI as storyteller and choice architect

Enhancing User Experience in VR Environments through AI-Driven Adaptive UI Design (researchgate.net)

Seamless multimodal engagement

User Tracking and Haptic Feedback driving more realistic XR interaction (xrtoday.com)

Emerging brain–computer interfaces enable hands-free control by translating neural signals directly into commands (medium.com)

Meta-review on Brain-Computer Interface (BCI) in the metaverse (doi.org)

Even lower latency gameplay with frame warp (nvidia.com)

Meta Quest 4 and Quest 4S (androidcentral.com)

Genie 3: Creating dynamic worlds that you can navigate in real-time (youtube.com)

"Voice recognition, eye tracking – these are all about lowering interaction effort for enhanced user experiences. Eventually, with brain-computer interfaces, we could all become XR developers!"

- **Omar Niamut**, TNO

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Education

- Conversational AI-based tutors could reduce instructor workload and reach larger student cohorts.
- AI-driven interactivity (including, for example, gamification) may enhance long-term student engagement, especially amongst younger learners.
- Conversational agents and personalised feedback systems support student study when human instructors are not available 24/7.

Research

- Context-aware virtual assistants accelerate scientific literature reviews and experiment configuration.
- Researchers can benefit from intelligent systems with AI-XR functionalities that adapt experimental pathways, offer real-time suggestions, and track engagement metrics for cognitive and emotional responses.

Operations

AI chatbots are already being used to answer routine queries from employees / professionals (for example IT or human resources queries), freeing staff time for more complex cases. This could evolve into 3D assistants in virtual or augmented workspaces.

TREND #4

Growing big tech competition for the XR stack

Public Values

Autonomy	Freedom of choice | Independence | Diversity
Justice	Equity | Inclusion
Humanity	Well Being | Social cohesion

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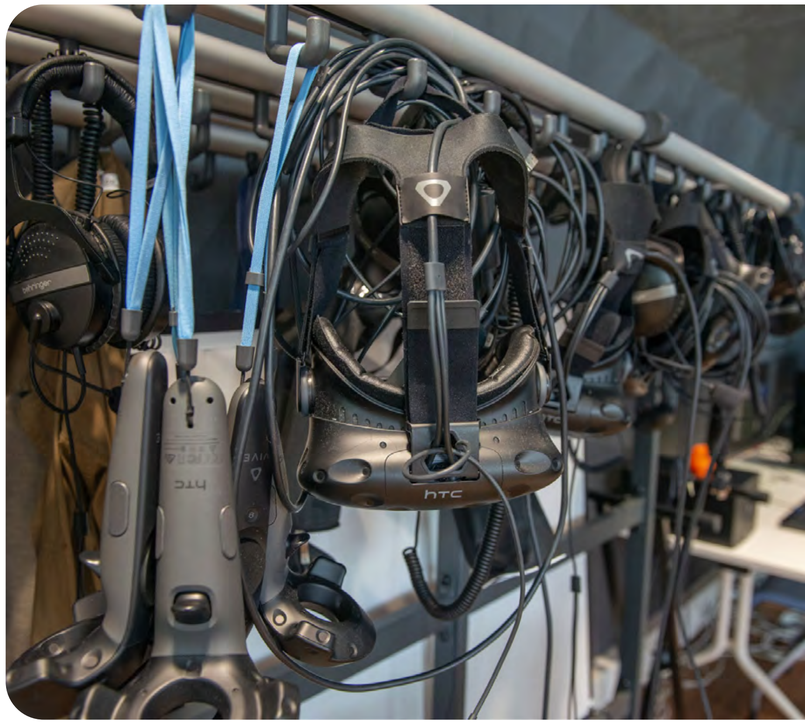
Drivers

Globalisation; Concentration of wealth & economic inequality; Ideologic polarisation

The XR stack is the set of technologies, components, platforms, and applications that is needed to offer XR/immersive experiences. A key development is the competition between big tech companies (Apple, Meta, Microsoft, and Google) – which is a repeating pattern – to create complete and leading XR stacks with associated ecosystems.

Control over head-mounted display hardware, operating systems, (AI-based) XR engines, middleware, and the adoption of virtual assistants is central to gaining a competitive edge in the XR market.

Big tech companies are progressing substantially on their XR stack control as they look at their portfolios of technologies, products, services, and partnerships. On the contrary, these same big tech companies are also participating in standardisation bodies and open XR initiatives.



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Meta opening up their Horizon OS to other manufacturers together with partners, AndroidXR announced with major partners

Introducing our open mixed reality ecosystem (about.fb.com)

Learn more about Android XR (android.com)

Strategic acquisitions

First smartphones, now Google acquires another HTC Division and also obtains a non-exclusive license to use HTC's XR intellectual property (androidauthority.com)

Most manufacturers have announced to use Meta's or Google's OS and platform

AndroidXR- Samsung, Lynx, Qualcomm, Xreal, Sony: Android XR: A new platform built for headsets and glasses (blog.google)

Meta Horizon OS- Microsoft, Lenovo, Asus Android XR: A new platform built for headsets and glasses (blog.google)

Google demos Android XR glasses at Google I/O 2025 with Gemini integration (youtube.com)

"The most forward-thinking creators are adopting AI tools quickly. They're not afraid—they're using them to push the limits of what's possible in immersive creation."

- Julie Smithson, METAVRSE & XR Women

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Education

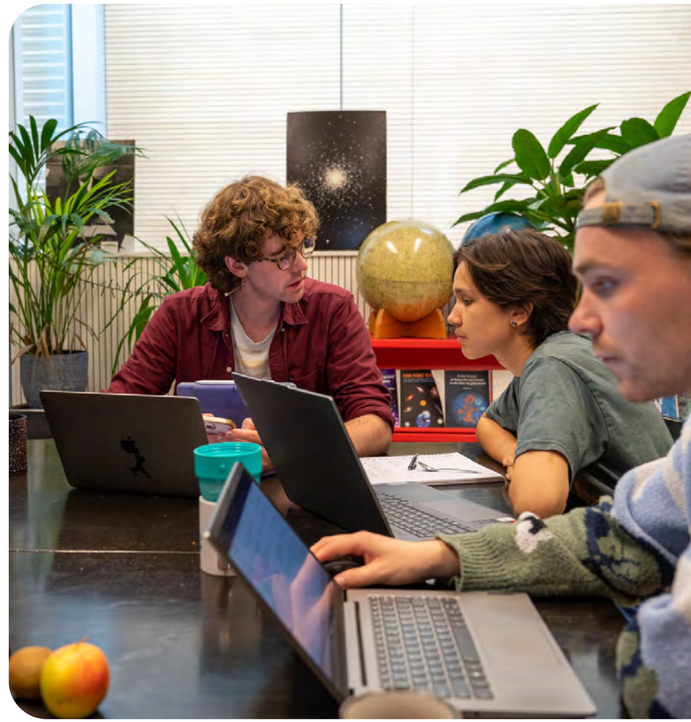
XR stack competition will affect the degree of privacy and data control within XR platforms and applications for educational purposes. Platform lock-in dictates long-term portability and interoperability of (costly) content, and therefore, careful procurement is needed.

Research

Access to lower levels of software within XR-related platforms and applications for certain research activities will likely be restricted within closed stack systems. This is particularly relevant to consumer-grade price point products available in the market.

Operations

The strategic choice of an XR ecosystem will significantly influence vendor dependence in areas such as interoperability, privacy and control, and ongoing maintenance costs.



TREND #5

Public investments in XR continue to increase

Public Values

Autonomy	Freedom of choice | Diversity | Independence | Privacy
Justice	Inclusion | Transparency | Equity
Humanity	Safety | Well-being

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Drivers

Value of knowledge & skills; Global trade & tariffs; Digital transformation; Geopolitics & (digital) sovereignty; Compliance & regulation; Critical infrastructure

Besides the large investments of big tech and other companies in (segments of) the XR stack also governments are starting to recognise XR's potential in innovation, productivity, and economic growth.

Therefore, in various domains and sectors, public investments in XR are growing both nationally and internationally, with a shift towards funding more practical applications and use cases. For example, in healthcare (surgical training and mental health therapy), in defence (combat training, drone management and operations), in urban planning, and in education programmes (simulator-trained professionals).

In the Netherlands, the establishment of large public-private research and innovation programs indicates substantial national public investment, alongside several Horizon Europe calls focusing on Virtual Worlds.

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Horizon Europe projects

XR Projects Financed under H2020 and Horizon Europe (ec.europa.eu)

Varjo suggests a shift to practical applications (varjo.com)

"Healthcare is a big area where investment is set to increase. There's a lot of funding going towards VR training and applications in the healthcare sector."

- Michael Barngrover, XR4Europe

National investments in education and training in Netherlands

- npuls.nl
- ciiic.nl
- dutch.technology
- rif-smart.nl
- oasis.nl

Defence

Five US navy warships get AR tech for remote-assisted repairs (thedefensepost.com)

European Defence Fund (eufundingoverview.be)

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Education

Increasing public investments in XR accelerate adoption in education, leading to more institutions gaining access to high-fidelity virtual environments like simulators and training applications.

Research

XR focused public funding could shift priorities to applied studies validating measurable quality gains of the real-life usage of virtual environments for training and simulations (such as fewer accidents and higher pass rates).

Operations

Better-organised research and innovation consortia accessing specific public funding pipelines on XR enable faster adoption and shared usage of XR infrastructures.

More info about Immersive Technologies? Visit surf.nl

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