

# Augmented Reality Technology for Safe and Efficient Construction Projects

## Background

Construction sites are inherently complex and dangerous environments due to their size, heterogeneity, and unique characteristics, such as location, construction processes, and resources to be employed. Each project operates as a prototype, requiring a tailored approach to its challenges. Over the years, tools like Building Information Modeling (BIM) and Digital Twins (DT) have been widely used as vital for integrating and managing diverse site information digitally (e.g., collected from deployed sensors).

Extended Reality (XR) technologies like Augmented Reality (AR) and Virtual Reality (VR) offer significant potential to push the boundaries of digital twinning. These technologies can provide workers and engineers with real-time, context-sensitive information directly in their field of view, reducing reliance on physical documents like construction drawings. The ability to rapidly access accurate, updated information can streamline operations, improve efficiency, and enhance safety. In particular, the operators could access current information and be even more protected against accidents and injuries, as the XR technology could provide feedback (e.g., alert) directly in the field in real-time. The construction of EuroTube's DemoTube (<https://eurotube.org/demotube/>), a hyperloop test infrastructure located in the Innovation Park Zürich, presents an ideal case study for applying and validating such technologies. By employing XR to guide operators through the construction process, akin to assembling a LEGO set, this project aims to revolutionize how information is delivered and utilized on-site.

## Goals / Methods / Approach

The project will be guided by the following steps:

(1) **Requirements Analysis:** analyzing the requirements of the DemoTube construction process and collaborating with EuroTube engineers will help identify the project workflow in detail, ensuring the system KPI prioritizes safety, production guidance, and quality control. This phase will clarify the functional requirements for integrating XR into the construction site.

(2) **Technology selection:** this step will involve selecting appropriate technologies. Hardware options for appropriate see-through XR devices will be evaluated (e.g., Microsoft HoloLens, Apple Vision Pro). Simultaneously, software tools for integrating BIM or Digital Twin models into the XR environment will be selected based on compatibility and usability.

(3) **System Design and Prototyping:** the system design phase will focus on creating AR workflows that overlay step-by-step instructions and critical safety information directly in the operator's field of view. This system will be the key part of the project and will be developed and tested iteratively to ensure alignment with the project objectives.

(4) **Field Deployment and Validation:** The prototype will be installed and tested on the DemoTube site, with operators using the system in real-world scenarios. Feedback will be collected from workers and engineers as well as from the use of the employed hardware.

A final documentation and reporting phase is expected as well.

## Required skills

Proficiency in understanding fundamental concepts of human-computer interaction and interaction design, as well as experience with XR development platforms like Unity or Unreal Engine, is expected. 3D modeling experience will help in BIM and Digital Twin tools. Familiarity with construction workflows, as well as the ability to design thinking and creative imagination, are a plus.

## Notes

The project language is English. This project is with an external partner (<https://eurotube.org>). It may lead to new research grant proposals and publications.

## Tasks

The project can be implemented in 2 to 3 stages, e.g., P7 (Concept generation and initial prototype), P8 (interaction flow design and implementation), and P9 (user study and further improvement).

<b>Studienart:</b>	<input checked="" type="checkbox"/> Full-time study <input checked="" type="checkbox"/> Part-time study 50%
<b>Projektorganisation:</b>	Individual or group work
<b>Arbeitsort:</b>	Windisch
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