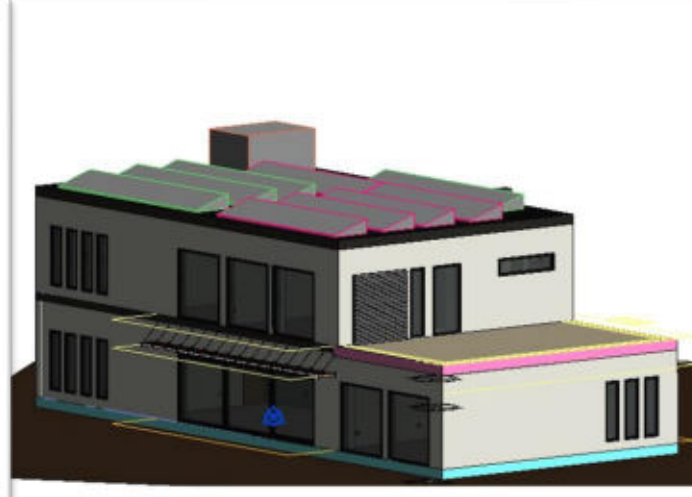


Augmented Reality and Deep Learning applications on Visual Quality Control in Construction



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CERTH
CENTRE FOR
RESEARCH & TECHNOLOGY
HELLAS



Who we are:

- Informatics Research Institute
- Digital Innovation Center
- More than 400 scientists
- Award winning research in over 20 fields

Center for Research and Technology Hellas Information Technologies Institute

CERTH:

Founded in **2000** and is one of the top 3 Research Centers in Greece

Houses five (5) Institutes:

- Chemical Process Engineering Research Institute (CPERI)
- Hellenic Institute of Transport (HIT)
- Institute of Applied Biotechnologies (IABT)
- Institute for Bio-Economics (IBIOE)

*CERTH/ITI: 1st in European Project Funding (FP7, H2020)
in Greece 5 years in a row*

Information Technology Institute

- CERTH member since 2000
- Top Institute in Greece in the fields of Informatics, Telematics and Telecommunications
- Total Budget > **150 M€**
 - ~**15 M€ Annual Funding from Research Projects**





COGITO Tools for Digital-Twin
Based Construction

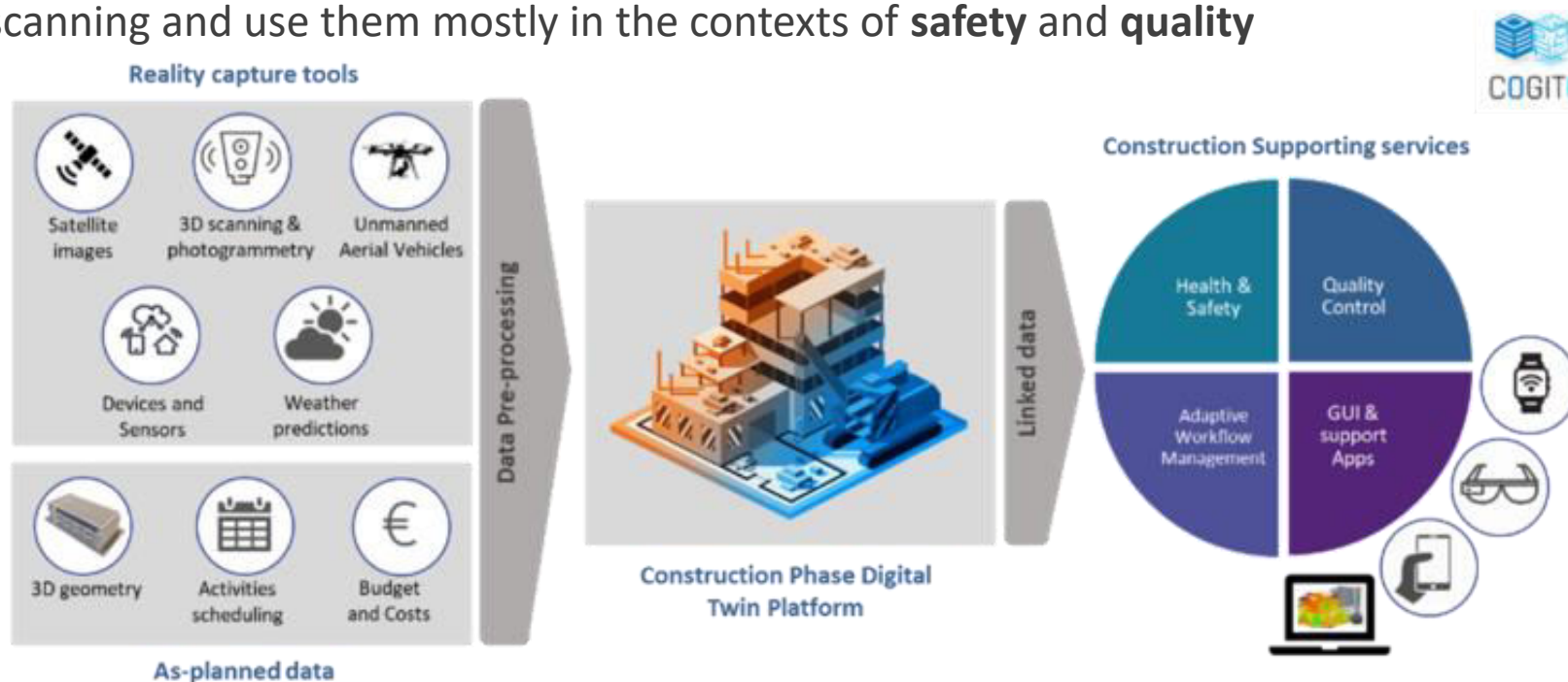
The COGITO Toolbox



COGITO Digital Construction 4.0 Toolbox is an EU funded Research Project started on November 2020 to develop and offer «Digital Twin» tools where using multiple reality capture source the aim is to enhance and optimize construction performance in the following aspects:

- **Safety, Quality, Workflow, Cost.**

CERTH is involved in developing reality capture, processing and visualization tools that aggregate data from: digital imaging and laser scanning and use them mostly in the contexts of **safety** and **quality**



The COGITO Toolbox



The toolkit will consist of:

- **Reality Capture and Registration tools**
- Multi-source **Preprocessing tools** to assist in the detection and tracking of defects, safety issues, people, materials and equipment
- **Adaptive Workflow Management tools** to organize and optimize resource allocation and work timeline.
- **Health and Safety AI** to minimize danger in the building site
- **Quality Control Services** for early detection of geometric and visual defects
- **Augmented and Virtual Reality UIs and Applications** to enhance construction worker interaction with the Digital Twin and to provide visualization for Quality Control, Health and Safety training as well as general assistance of crews in the field





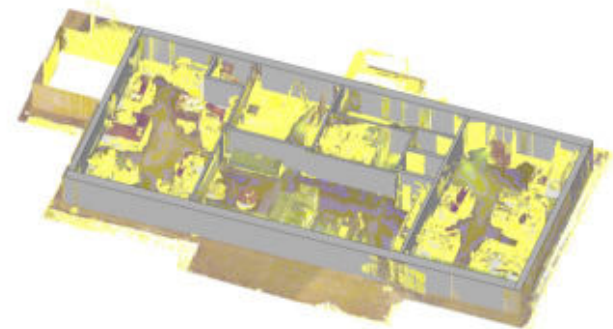
Quality Control in Construction:

- Visual Defect QC
- Geometric Defect QC
- Deep Learning Detection and Annotation

Visual and Geometric Quality Control

Within COGITO a main objective is to digitize and partially automate the Visual and Geometric Quality Control processes using Digital Twin technologies. In detail: Capture, aggregate and preprocess imagery from multiple sources – mobile phones, AR goggles, multimodal UAV-mounted cameras, optical and depth inputs, satellite imagery databases as well as point clouds and geometric data

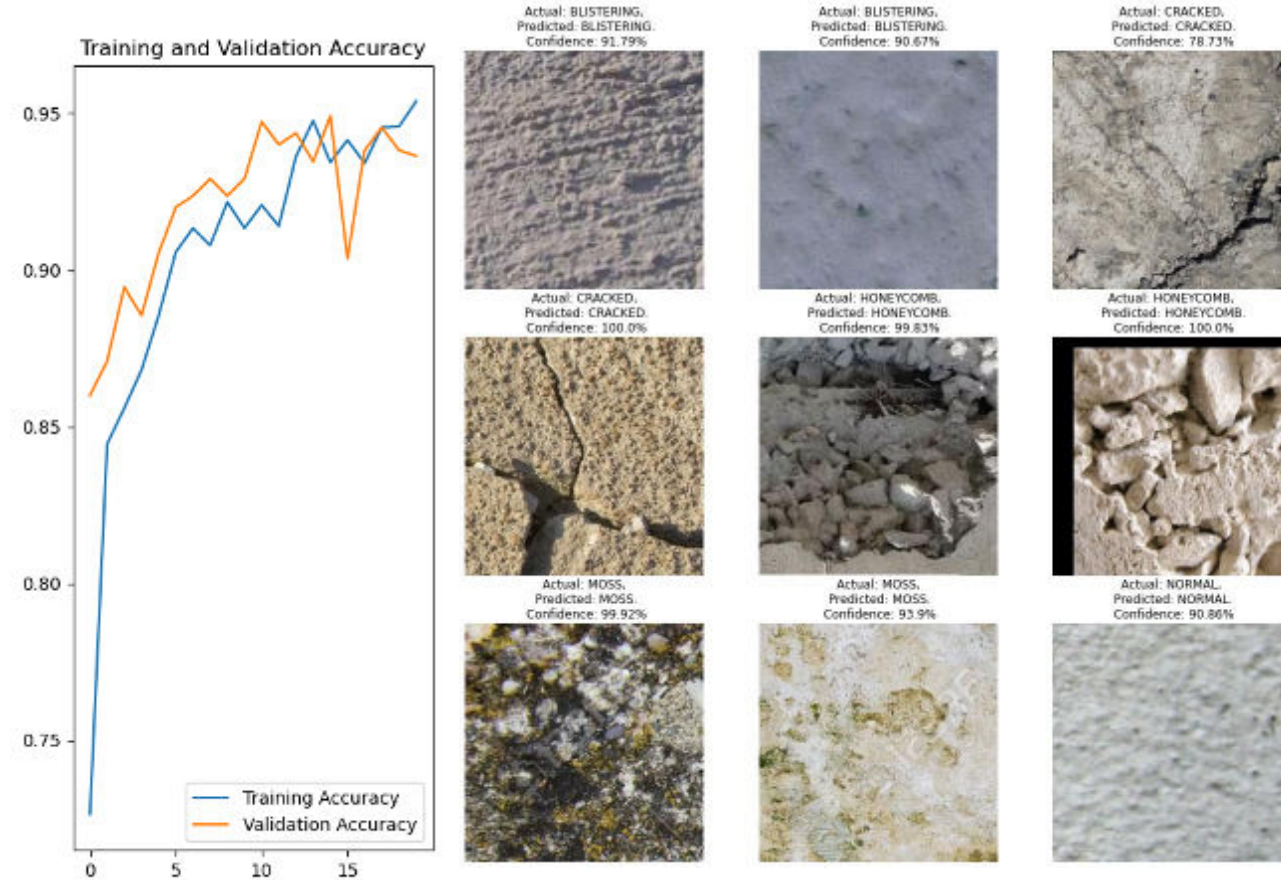
- Pre-process raw imagery:
 - Input filtering, where inputs will be smoothed, denoised and enhanced, utilizing multimodality and cross-channel input correlation where applicable,
 - Cross-channel registration of visual inputs and registration of visuals with structural and geometric data.
- Geometric QC
Develop algorithms that **automatically apply Standard Test Methods for Geometric QC** using laser scanning and BIM. **Implement Scan-vs-BIM solution** to match as-build point clouds to as-designed BIM elements.
- Visual QC
Develop algorithms to **automatically detect common construction defects** in images



Deep Learning in Visual QC

Deep Learning algorithms for Defect Detection based on:

- Type of Defect (Cracks, Honeycomb, Corrosion, Corrosion, Segregation, Blistering etc.)
- Type of Structure (Concrete / Steel Structures, Linear Infrastructure, Pipes)
- Estimation of Severity
- **Pre-trained Models** on diverse Datasets with single and multi-class detection
- **Transfer learning:** Fine tuning technique to train existing models in our own specific dataset, classes etc.
- **Data Augmentation and filtering:** Using the Visual Preprocessing Toolkit to provide more samples for training and optimized input data for defect detection



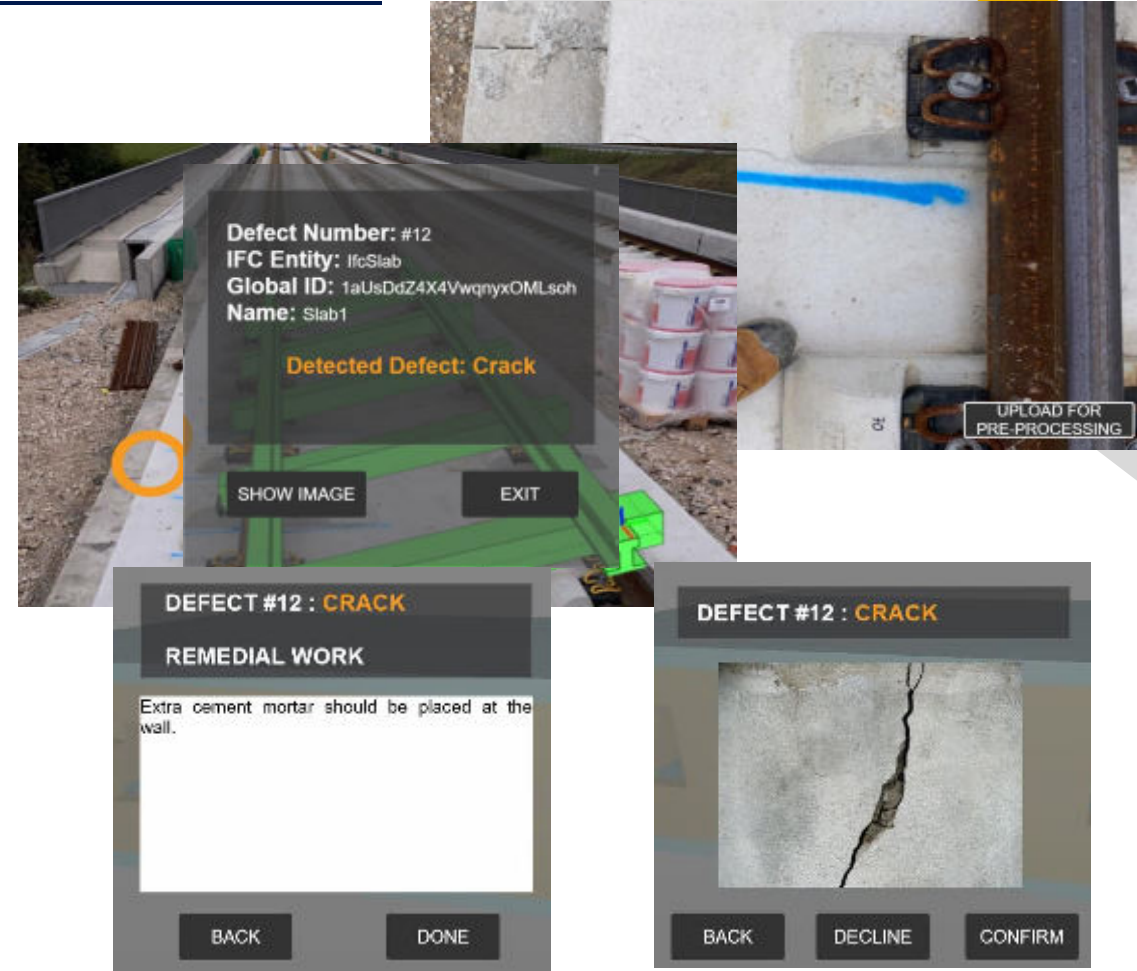
Augmented Reality (AR) in COGITO

Quality Control/Safety:

- **Improvement of QC** through visual comparison of as-designed versus as-built
- **Safety Measure Audits** on location based on planned interventions.
- **Defect and safety measure issue annotation** with remedial work allocation along with comments and imagery
- **Hands-free information retrieval:** The worker can access Building information without paperwork or referring to designs in 2D

Operations and Maintenance:

- Localized building element information retrieval on-site.
- Work order information and generation based on on-site observation
- Improvement in accuracy, efficiency and standards compliance.

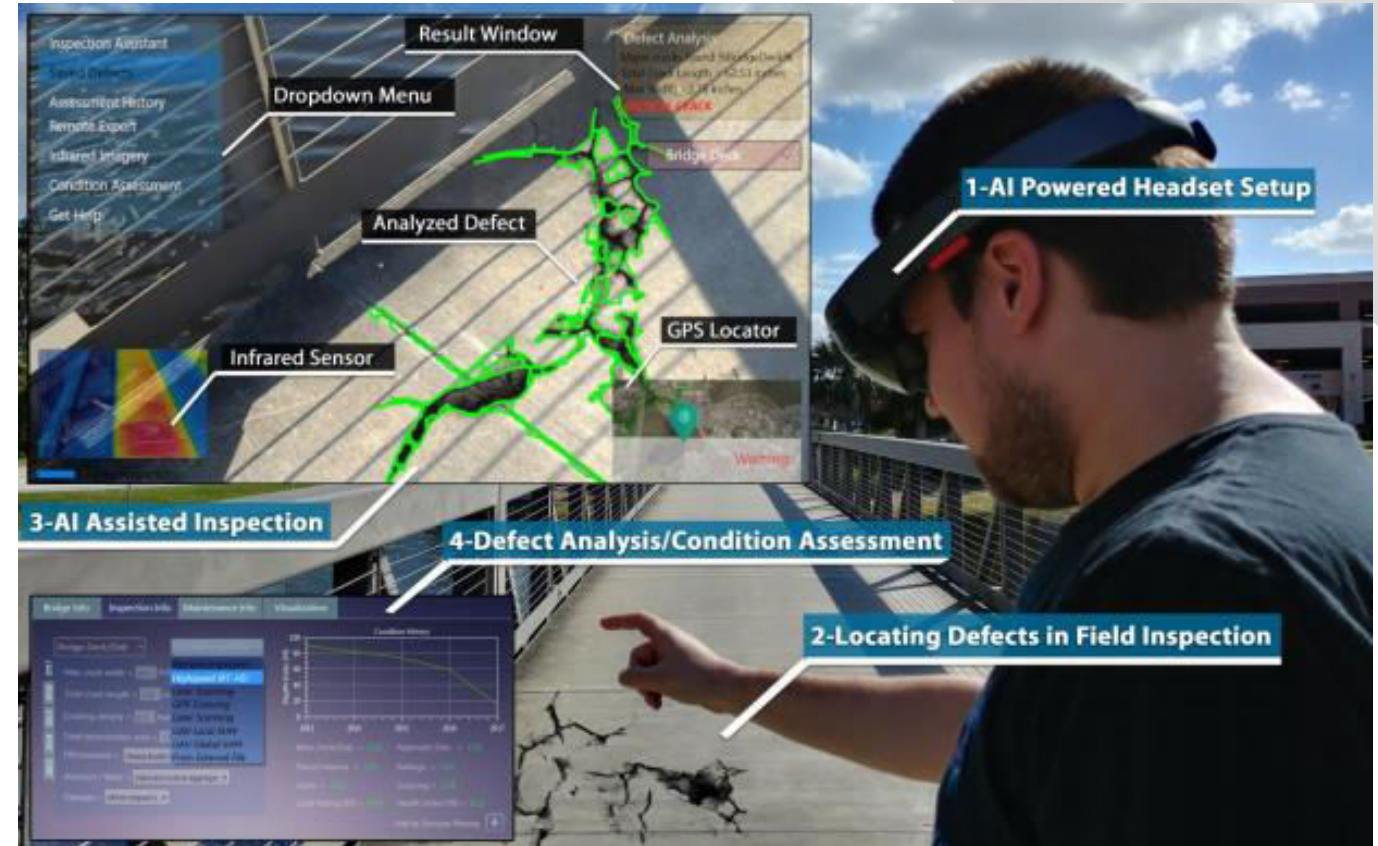


Augmented Reality (AR) in COGITO

Visual Quality Control:

In this use case AR is used in:

- **Detection and Annotation of Defects** registered on the physical world elements through the AR device localization sensors and cameras
- **QC Visualisation** of offline detection of defects (elements where construction defects were found through the GeometricQC and VisualQC tools) to assist in the addition of new remedial tasks within the workflow.
- **On-site Verification of suspected defects** and finalization of generated remedial works



Augmented Reality (AR) in COGITO

Health and Safety:

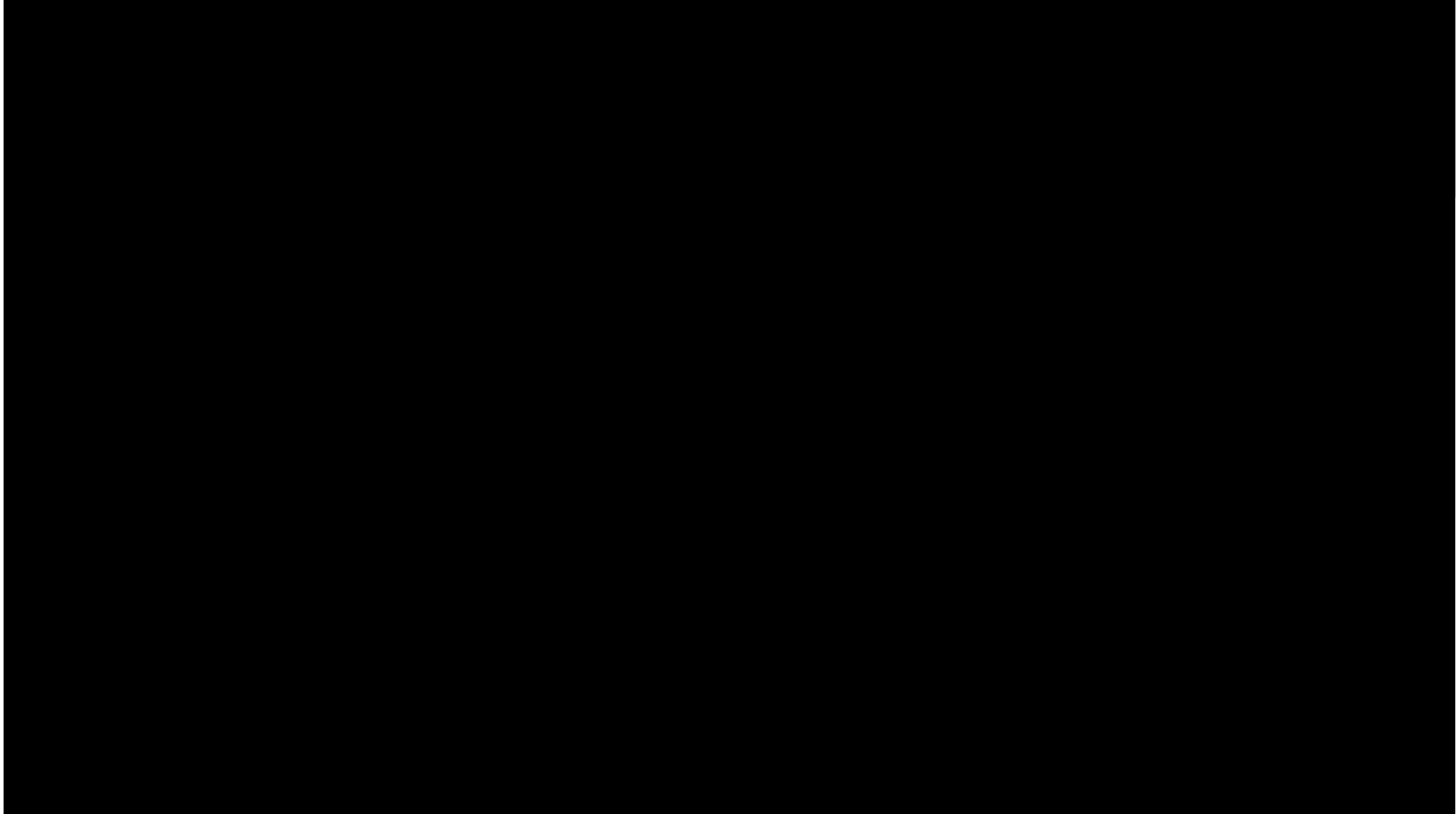
In this use case AR is used in:

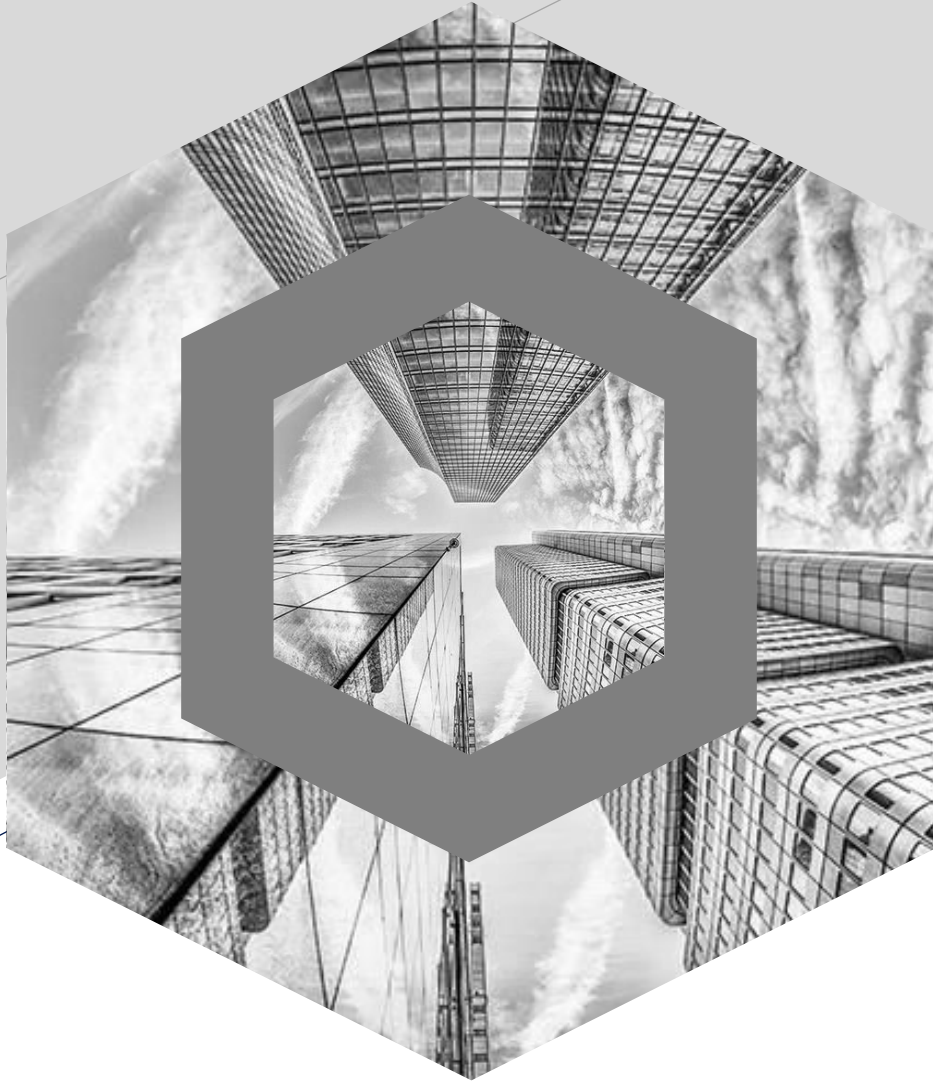
- **Location tracking and visualisation of resources** (equipment, materials and personnel) in the construction site
- **Augmented Safety Notification to avoid near-misses and accidents** (defined as collisions that could lead to injury and death) and reduce collateral damage (defined as damages to equipment or temporary installations and materials/structures)
- **Augmented 4D (as-built) BIM / DT model** with safety information, modelled safety installations and incident reduction plans applied within the construction site
- **Augmented Safety Audits** to identify missing safety precautions



- **Integration of Safety Rules and Regulations** within the BIM/DT model

Augmented Reality (AR) in COGITO





Thank you for your attention



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