Applications of Augmented Reality Integrations for Construction and Design

Allison Yanites and Anna Figueroa-Soldner

Immersive Technology Lead, North America; Architectural Designer/BIM Coordinator

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About the speakers

Allison Yanites

Allison Yanites is the Immersive Technology Lead at Arcadis, North America, where she collaborates with global leaders to advance immersive technology (AR/VR/MR) solutions across design and consultancy work in infrastructure, building, water, and environmental industries. These solutions include on-site AR design visualization, hands-free remote assistance, 360-degree virtual asset data models, mobile AR, and VR design visualization.

Allison is focused on identifying and implementing immersive and wearable technologies to create intuitive and interactive experiences for our project teams, clients, and stakeholders to improve communication, collaboration, understanding, and health and safety.

Anna Figueroa-Soldner

Anna Figueroa-Soldner is a BIM Coordinator for Arcadis North America, in their Toledo, Ohio office. She obtained her Bachelors and Master's degree in Architecture from Savannah College of Art and Design, in Savannah, GA. She worked in the Architectural field for 11 years, but her career path took her into the BIM Coordination and management direction. Her main focus is on coordinating multiple disciplines while working in REVIT, Navisworks, Civil 3D and BIM 360. She helped in the office transition from CAD to BIM and continues to help implement and develop standards, template creation and mentoring new REVIT modelers. She is now applying AR/VR/MR to her projects to assist in the design process and during construction.


Augmented Reality is changing the way we work


Increased safety
Cost reduction
Speed of decision-making
Enhanced communication

Technology Adoption

Building information modeling

Basic data analytics

Project management information systems

Mobile platforms

Drones

Virtual reality

Smart sensors advanced data analytics

Augmented reality

RFID

3D printing

Machine engineering and design

Artificial intelligence

Robotics

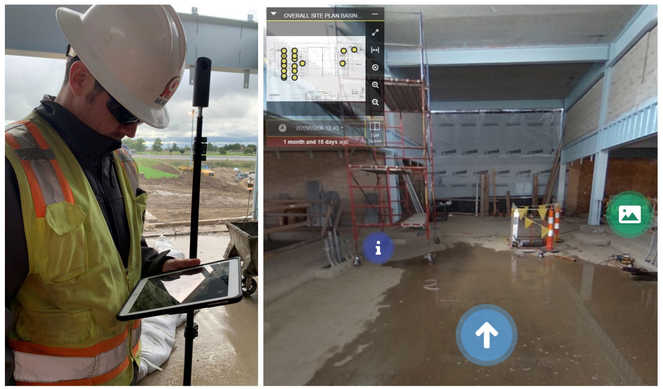
Cognitive machine-learning

Source: Raconteur 2019

AUGMENTED REALITY

Real Environment

Your real world around you.



360° Reality Capture

Virtual Reality

Entirely simulated version of the real world (or any world!).

Remote Assistance

AR/MR 3D Visualization

Level of immersion

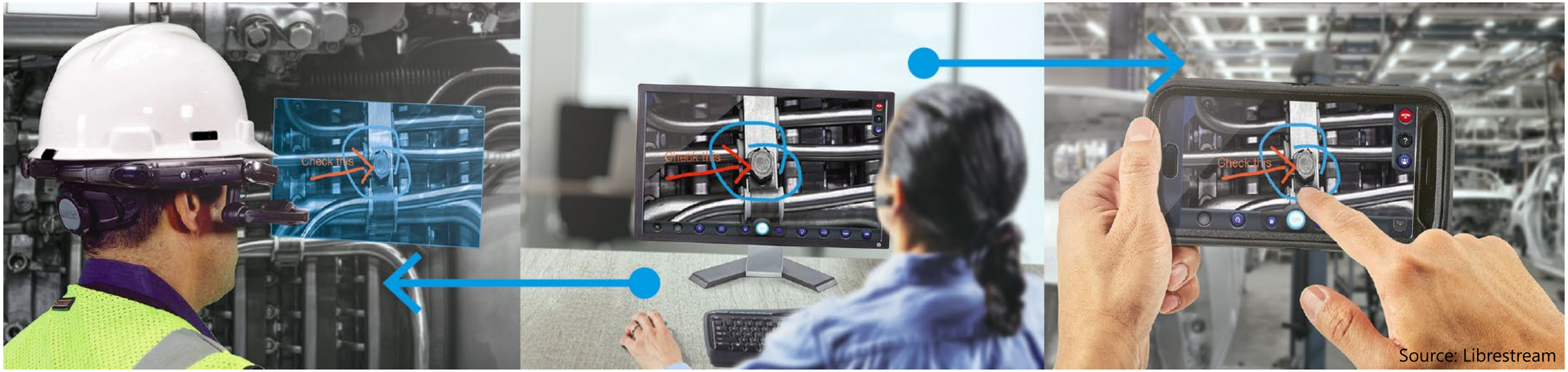
Water Treatment Plant
Design & Construction Management

- For this site, we pushed models from Revit of the Main Gallery, Pipe Gallery, Effluent Building, and Sedimentation Basins
- 40MG addition/renovation of existing 40 & 80MG basins.
- 5 stages to the project.
- A360 Teams & BIM 360
- Point Clouds/Record drawings
- Remote Expert during design
- HoloBuilder during construction
- VisualLive during design and construction

1 | REMOTE ASSISTANCE

- Increased safety
- Cost reduction
- Speed of decision-making
- Enhanced communication

Remote Assistance: hands-free ‘FaceTime’



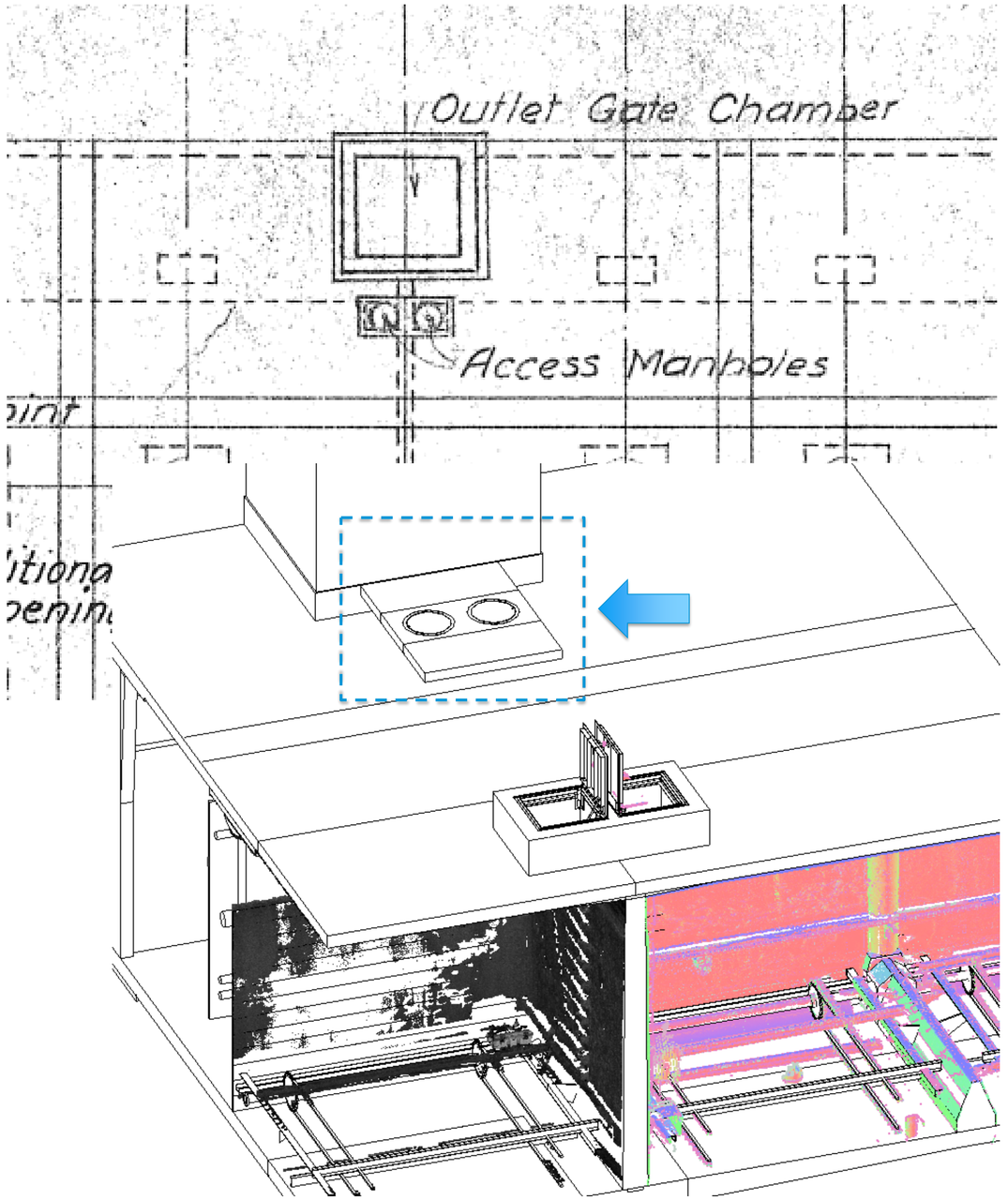
Hands-free headset connects via App to PC, mobile devices

Features

- Real-time video collaboration
- Annotate real-time video
- Share documents
- Waterproof, dust-tight, drop-proof
- PPE compatible
- Group calls

Application of Remote Assistance for Design & Construction Management

- 1940's record drawings show the manholes but give no further information other than a size for the manhole cover.
- Our Point Cloud stopped at the south of the manholes and never picked them up. Site survey didn’t locate them either.
- Site visit was required to locate and measure the concrete slabs and manholes.



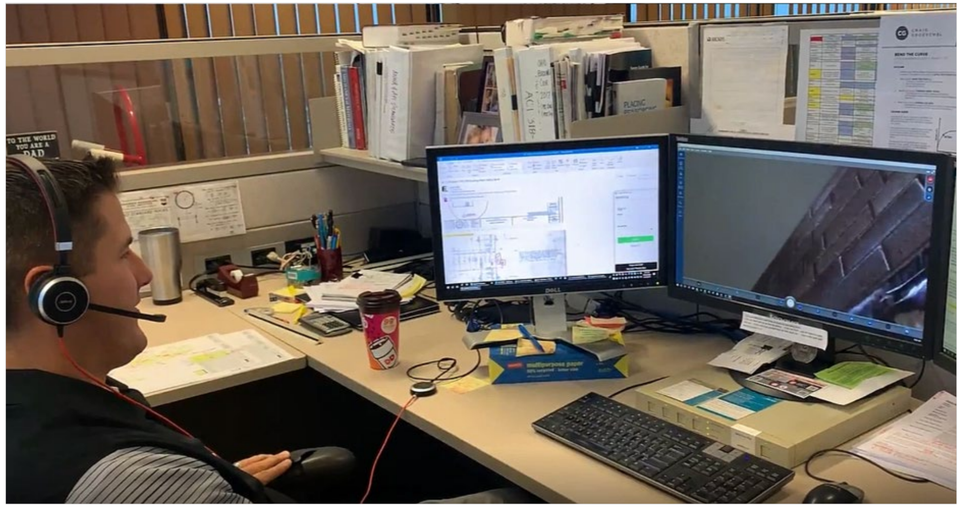
Remote Measurement Confirmation

- Problem: Design team needed measurements to confirm dimensions for BIM model.
- Solution: BIM Design Coordinator and On-site Construction Manager connected via videoconference.
- 5-minute phone call replaced capturing pictures + email or phone conversation and/or site visit.

https://autode.sk/2rAkmrb

Remote Construction Management Discussion

- Problem: Gas line dimensions have changed.
- Construction manager and Construction lead discuss changes.
- 5-minute phone call replaced capturing pictures + email or phone conversation and/or site visit.



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Integrations

- Captured photos and video can be integrated with:
  - BIM360
  - SharePoint
  - OnDrive
  - Project files
  - Other documentation

User Experience

EASE OF SETUP

- Mobile use requires login and app download.
- Hands-free requires more training to setup headset with WiFi connection and learn navigation

USABILITY

- Mobile – familiar, easy to use, easy to troubleshoot
- Hands-free harder to troubleshoot audio/video issues.
- **Office-staff can host and control call settings, video, pictures, etc.**

RELIABILITY

- **Calls rely on WiFi/Cell signal**

EQUIPMENT

- **Mobile devices are familiar**
- **Hands-free headset requires more training**
- **Hands-free offers mobility and safety on site**

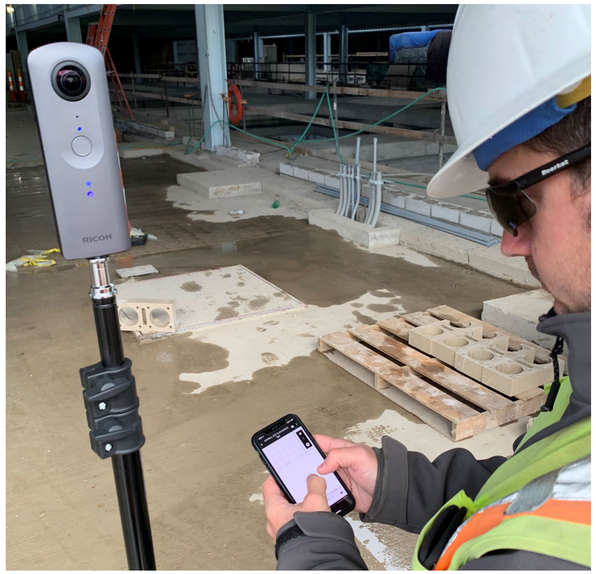
2 | 360° REALITY CAPTURE

- Increased safety
- Cost reduction
- Speed of decision-making
- Enhanced communication

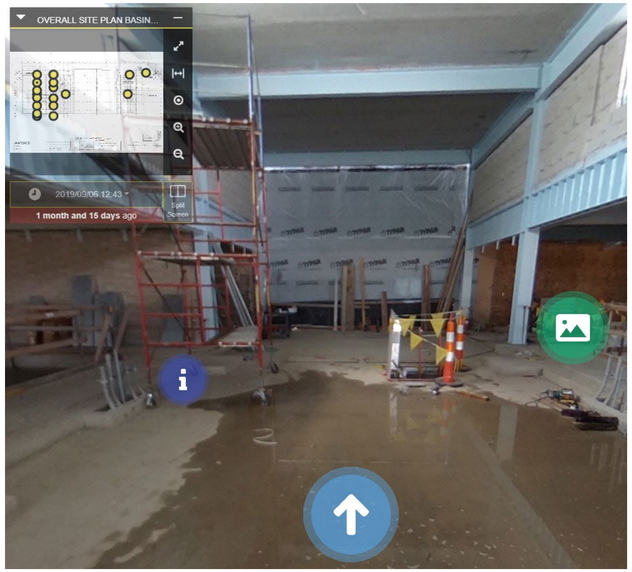
360º Reality Capture: ‘google street view’ for projects

Hardware

Process



Result & Value



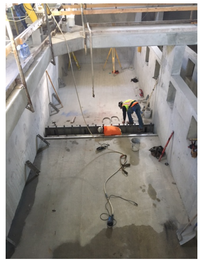
View 360 site models on
PC, mobile devices, VR

Features

- Unlimited photos within space
- Mobile app streamlines field capture
- Augment photos with text, drawings, PDFs, 2D photos, 3D objects, video, weblinks
- Measurement tools
- Integrate 3D model into project
- Split-screen mode to compare photos or model
- Integrate with BIM360, Revit, Navisworks, others
- SpeedMode automates photo capture at waypoints

Application of 360° Reality Capture for Construction Management

- Weekly 360-photo capture of the Main Gallery, Pipe Gallery, Effluent Building, and Sedimentation Basins
- 360-reality capture benefits:
  - **Construction Management**: Simple, efficient, intuitive way to communicate and document construction progress.
  - **Reporting**: Could replace daily/weekly construction reports – both with interactive HoloBuilder platform, but also with PDF reports from the platform.
  - **Communication**: Connects off-site team to site conditions in almost real-time. Problems are clearer, decision-making is faster, time and resources are saved.



PCM Team (Arcadis)

DAILY CONSTRUCTION REPORT

PROJECT: [redacted] CONTRACT: [redacted] REPORT NO: [redacted]

LOCATION: [redacted] DAY: Tuesday DATE: 11/05/19

CONTRACTOR: [redacted] RPR/ENGINEER: [redacted]

WEATHER		SITE CONDITIONS		WORK FORCE INCLUDING SUB-CONTRACTORS									
S					F			F			F		
Temp AM	42	Dry	X	Superintendent		2	Ironworker	1		Plumber			
Temp PM	48	Wet		Laborer	1	9	Mason	1	11	Welder		1	
Wind MPH	15	Frozen		Operator		3	Painter	1	2	Pump Trk.			
Dry	X	Sand		Carpenter	2	8	Electrician	1	10	Trucker			
Rain		Clay		Finisher			Roofer			Saw Cutter			
Snow		Rock		Surveyor			Fence			Pipe fitter	1	2	

OPERATING EQUIPMENT:

Loader	1	Dozer	2	Crane	3	Backhoe	1	Excavator	1	Compactor	1
GradeAll	3	Broom	1	Gator	6	Man Lift	5	Bobcat	1	Truck	1
Welder	1	AirCom	2	Welder	1	Generator	2	Ground Heater			
Others:											

SUBCONTRACTORS:

WORK COMPLETED:

[redacted]

Continued the EPDM roofing installation process above the North Filters in Area [redacted]
Completed sand blasting and prime coat painting the southern four of six remaining existing [redacted] structural steel beams adjacent to the North Filters and the Flocculation Basin in Areas [redacted]
Completed Sedimentation Basin chain and flight drive chain installation in Area [redacted]
Continued sheet membrane waterproofing installation atop the Sedimentation Basin deck in Areas [redacted]

[redacted]

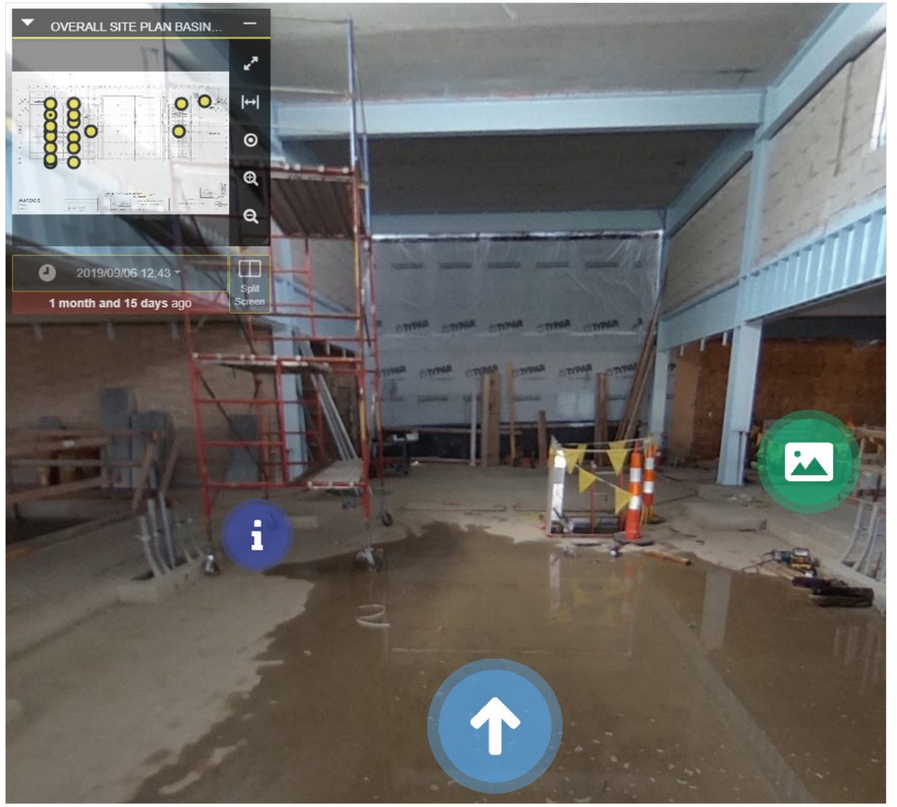
Continued filter bottom assembly in Filter [redacted] began loading filter bottoms into Filter [redacted] and continued the aeration header installation process in the eastern half of Filter [redacted] in Area [redacted]
Continued brick "wrapping" of structural steel column row JJ south of the South Filters and began same on adjacent column row 2 in Area [redacted]
Continued caulking the precast roofing plank joints above the South Filters in Area [redacted]
Completed cross trough installation preparation (bracket installation) for Filters [redacted] in Area [redacted]
Began structural brick placement along column line 13 (east Flocculation Basin interior wall) in Area [redacted]
Continued brick "wrapping" of the structural steel columns amongst the Flocculation Basin catwalks in Area [redacted]
Began sheet membrane waterproofing installation atop the Sedimentation Basin deck in Area [redacted]
Continued installation of the temporary copper Effluent Launder Building CO2 line from the existing line tie-in point near the CO2 storage tanks to across and above existing [redacted] Sedimentation Basins in Area [redacted]
Placed 6.5 CY of Class B concrete encasing the remainder of the northern waste wash conduit.

COMMENTS: Completed fusing together segments of the site HDPE natural gas line and made the east/west directional drill and pull.

BY: [redacted]

360° Site Model

- Active construction areas captured weekly
- Platform is used for documentation, communication, progress reports
- Video:
  - Overview map orients user to site
  - Navigate virtually through site, similar to google street view
  - Augment photos with text, drawings, PDFs, 2D photos, 3D objects, video, weblinks
  - Measurement tools
  - Split-screen mode to compare photos through time



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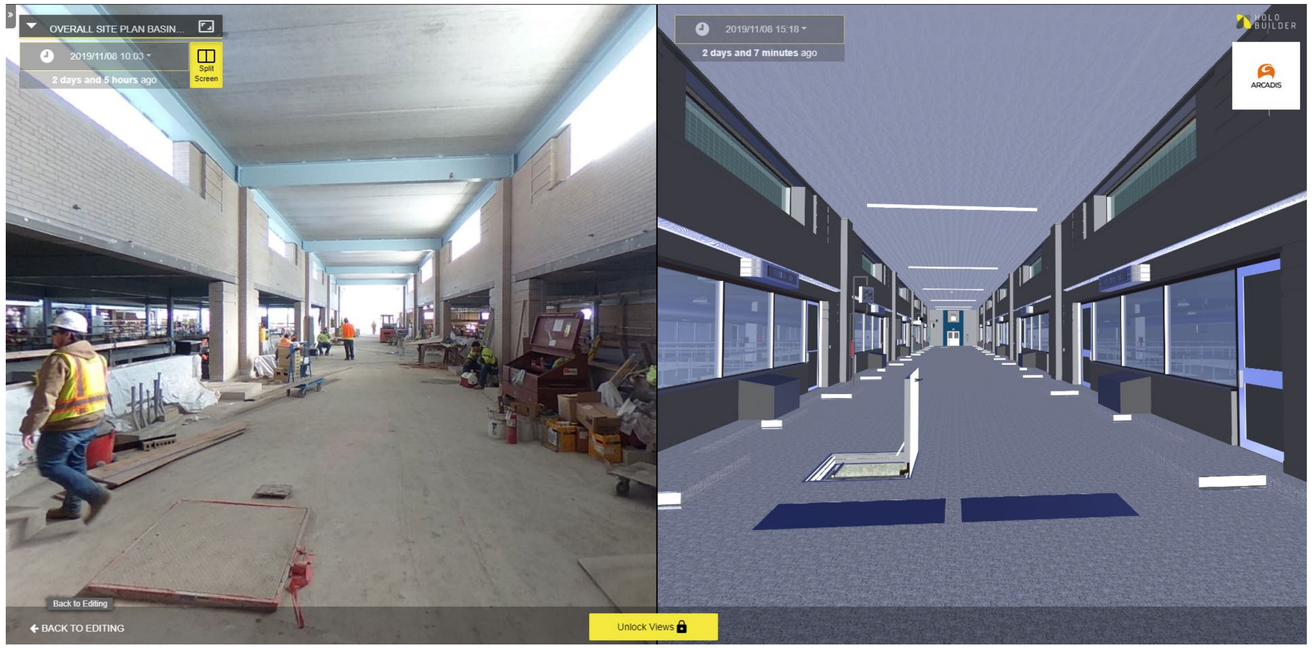
360° Site Model Navisworks Integration

- 100% 3D design integrated with 360 platform
- Design visualization, issue tracking, understanding, engagement
- Video:
  - Overview map orients user to site
  - Integrate 3D model (Revit, Navisworks) into project
  - Split-screen mode to compare model and photos



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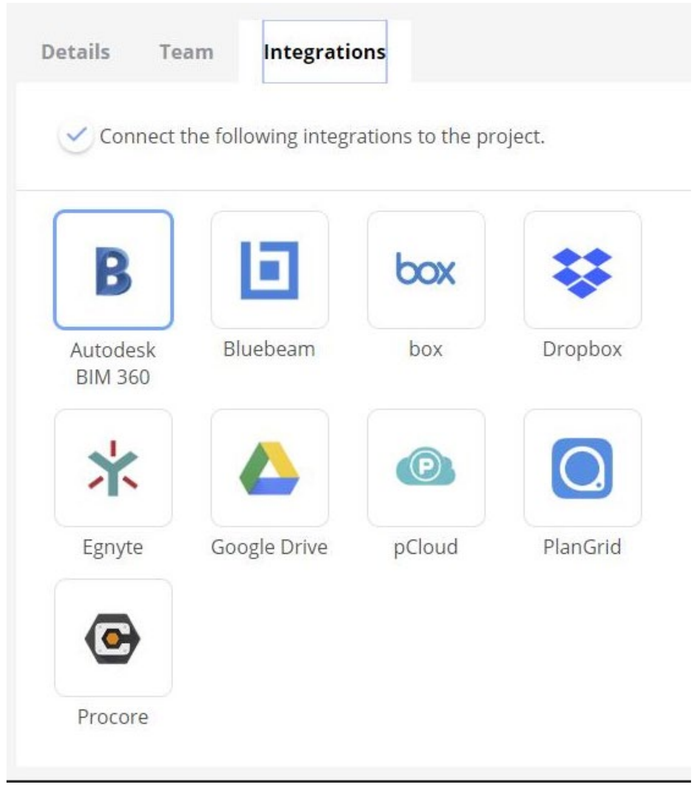
Integrations

Issue tracking



Embed link to BIM 360 dashboard

AUTODESK BIM 360

Integrating 3D Model

AUTODESK NAVISWORKS

AUTODESK REVIT

User Experience

EASE OF SETUP

- **Limited training**
- Procure space
- **Navisworks integration does require training, setup & coordination**
- **Larger files takes time to process**

USABILITY

- **Simple, fast to capture**
- Selected editors can view/edit 24/7
- **Viewers can access 24/7, see updates immediately**

RELIABILITY

- **Sync from field requires WiFi, may not be immediate**
- **Download project prior to capture for best results**
- Camera calibration can cause pictures to be off-alignment

EQUIPMENT

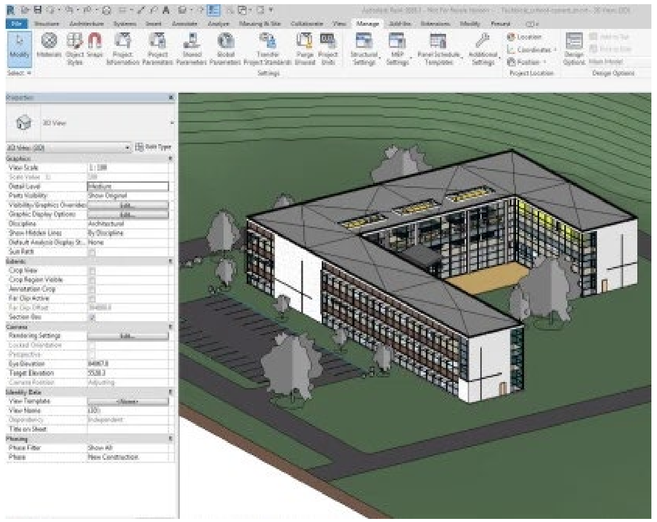
- **Camera is small, rugged, simple to use**
- **Affordable camera options**
- **Tripods can simplify consistency**

3 | 3D DESIGN VISUALIZATION


Increased safety
Cost reduction
Speed of decision-making
Enhanced communication

AR/MR 3D Design Visualization

Revit/Navisworks → AR/MR



View with mobile device or HoloLens

MobiLive HoloLive

See digital overlay

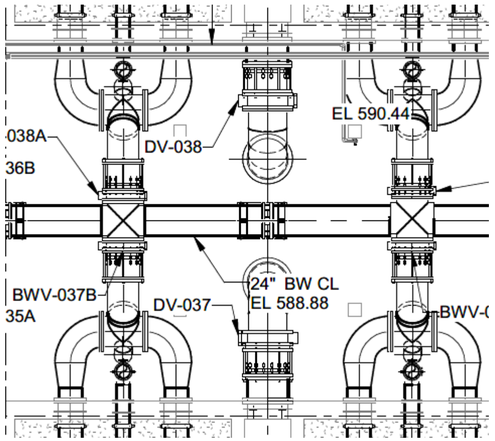
View 3D models in AR on mobile devices or in MR on HoloLens

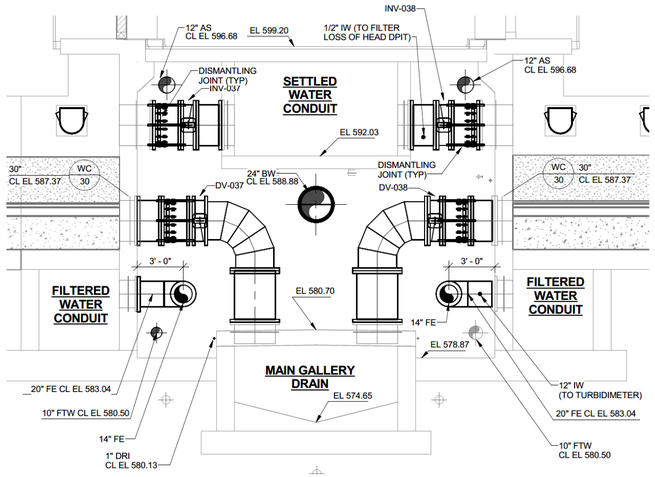
Features

- "See the unseen" (not-yet built, asset information, behind drywall)
- Locate and verify assets
- Flexibility to visualize with HoloLens or mobile device
- Capture and share photos, videos
- Issue tracking connected to BIM360
- Measuring tools
- Turn model layers on/off to isolate specific model layers for optimal on-site visualization
- Options to adjust (and save) alignment; lock model to reduce drift
- Sync AR models to device for offline viewing

Application of 3D Design Visualization for Construction Management

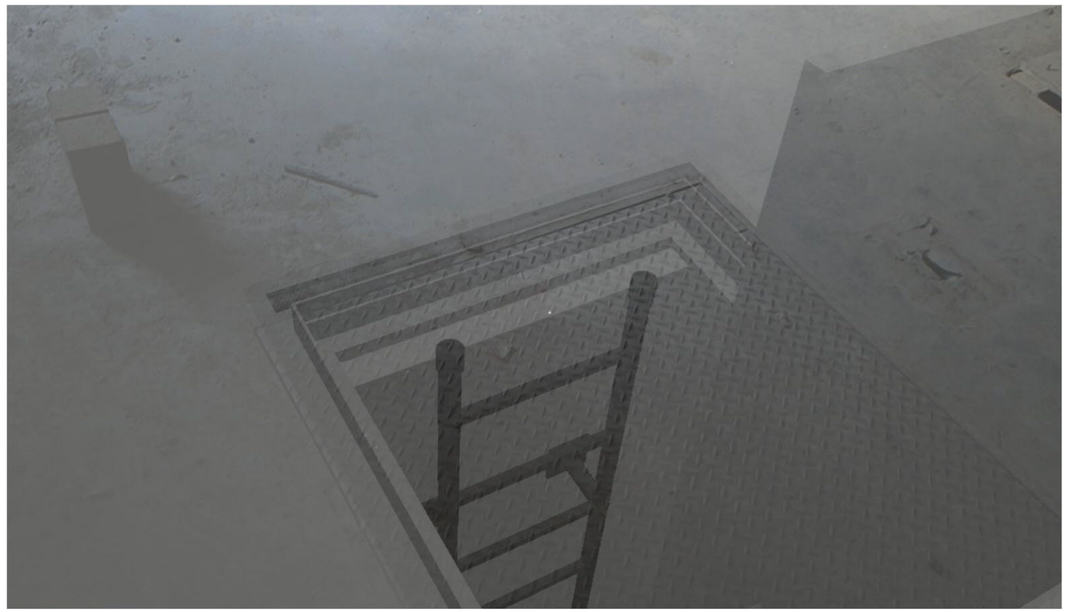
- We pushed models from **Revit** of the Main Gallery, Pipe Gallery, Effluent Building, and Sedimentation Basins
- AR/MR visualization benefits:
  - **Design Review**: Intuitive way to visualize design elements not-yet constructed
  - **Clash Detection**: Overlay digital model and reality to easily compare built assets to modeled assets for quality reviews and record drawings.
  - **Install Validation**: Prior to construction (ongoing process), use digital model to verify planned work to avoid re-work





Mixed Reality Visualization (from HoloLens)

- Video from the HoloLens, showing a modeled ladder hatch.
- In reality, the hatch is closed, but the Mixed Reality model shows the ‘unseen’ underneath the hatch door.
- In this example, MR model can be used to verify design alignment, and also help stakeholders visualize and understand the final design simultaneously with construction.



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Mixed Reality Visualization (from HoloLens)

- Video from the HoloLens, showing a digital overlay of the 3D design in the Pipe Gallery.
- In reality, “green pipe” is not green – the digital model aligns well on site.
- In this example, MR model can be used to verify design alignment and detect and document any differences.

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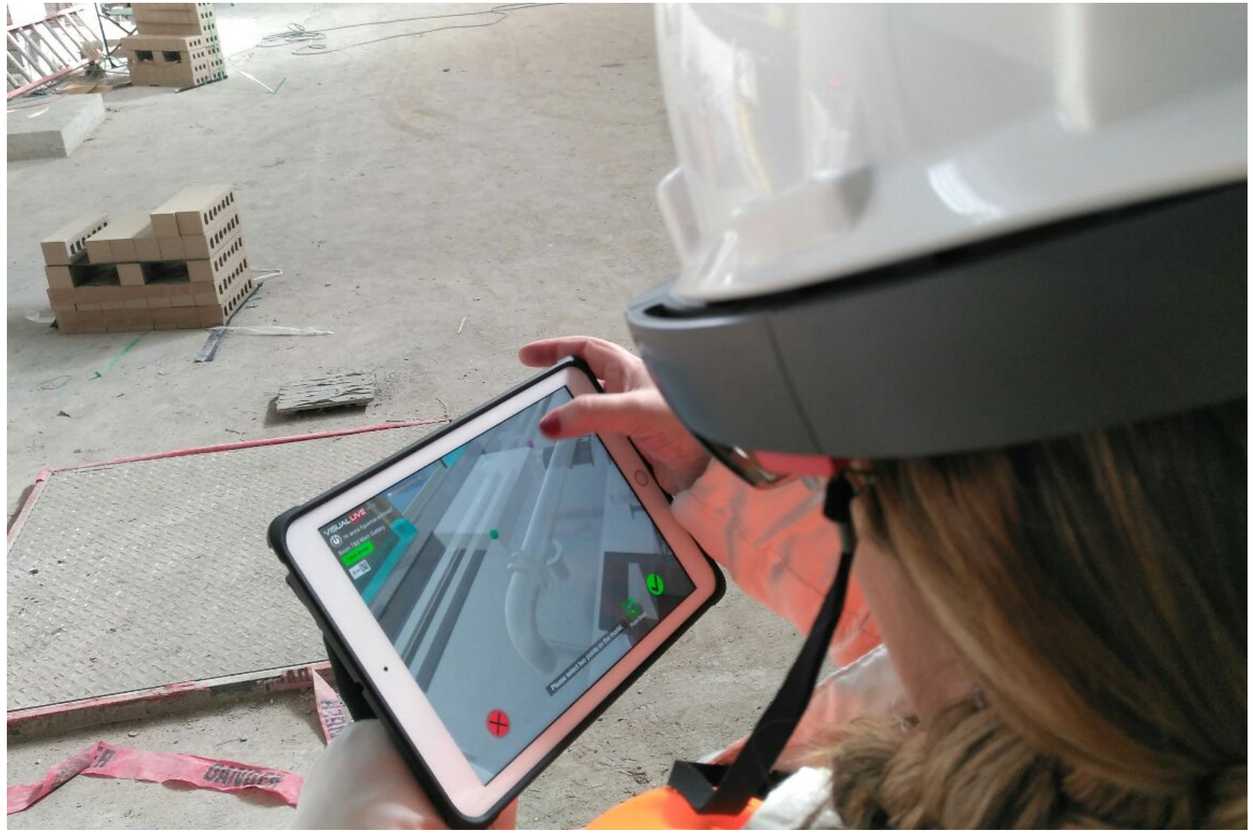
Augmented Reality Visualization (iPad)



Integrations

AUTODESK® NAVISWORKS®

AUTODESK® REVIT®

Load models from other sources

SketchUp

OBJ

FBX

User Experience

EASE OF SETUP

- **More Training Required**
- Licensed device needed
- **Some setup is required for model pushing**

USABILITY

- HoloLens takes longer to learn
- Mobile hardware is more familiar
- **After models are loaded and aligned, app interface is intuitive**

RELIABILITY

- Ability to sync models to device to load offline
- **Issues with models loading with correct alignment**
- **HoloLens can be a little buggy**

EQUIPMENT

- **Mobile devices are familiar and can be ruggedized**
- HoloLens is not rugged
- **Battery life sensitive to ambient temperature**

Summary


Augmented Reality is changing the way we work

Evolution of the Mobile Phone

Thank You!

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