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BIM 360 VR Collaboration for AEC/Construction with InsiteVR, Unity and Forge

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### Learning Objectives

- Learn about collaborative VR
- Learn about groundbreaking new VR hardware like Oculus Quest
- Learn how to bring BIM 360 models into VR
- Learn how to customize the BIM 360 web page

### Description

InsiteVR brings VR collaboration to the AEC industry. Teams already using BIM 360 can extend their workflow into collaborative VR by accessing the latest models, reviewing them and adding BIM 360 issues directly within VR headsets. InsiteVR leveraged Forge APIs and the Unity game engine to bring the power of BIM 360 collaboration onto groundbreaking new hardware, Oculus Quest. This class will discuss techniques used to view large scenes on Quest VR hardware for a delightful user experience. The class also discusses how the "View in VR" button was added directly inside the BIM 360 web viewer. InsiteVR will also showcase a few customer success stories using the BIM 360 integration. Attendees will participate in a live demo of a live multi-user VR meeting using the latest standalone VR hardware.
Speaker(s)

Angel Say

Angel Say is CEO of InsiteVR. He has been working on virtual reality since 2015 when the Oculus Rift Development Kit 1 was released. As a mechanical engineering undergrad at Columbia University in NYC, Angel experienced a $200M construction project block the campus observatory's view of the stars, which later inspired the first version of InsiteVR at a hackathon. In January 2015, Angel co-founded InsiteVR with his college roommate and joined the prestigious Y-Combinator incubator as one it's earliest VR investments. Prior to founding InsiteVR, Angel worked on projects ranging from mechanical design of a brain-controlled robot to computer vision software for autonomous microscopes.

Michael Beale

Michael Beale is a Forge Evangelist for the Autodesk Forge Partner Development team. Before joining the Forge Platform Team, Michael worked on Autodesk Homestyler, Cloud Rendering, Stereo Panorama Service and A360 Interactive Cloud Renderer. He also worked on the ‘Forge Viewer’ and Viewing APIs. Originally from "Down Under" Australia, Michael tends to confuse camera Z-up with ‘camera Z-down’. More at twitter @micbeale Blog: https://forge.autodesk.com/author/michael-beale
Collaborative Virtual Reality for AEC

Imagine having a virtual conference room you could access at any time with a full scale version of your project waiting inside. With today’s VR technology, it’s possible to review project models with users in different locations and with minimal set up. This course will cover everything from hardware to software that projects can use to start reviewing BIM 360 projects together in VR.

Improving Project Delivery with Collaborative VR

The interdisciplinary nature of the building industry requires efficient communication throughout phases of a project. At every step of the process information is transferred between various parties including architects, engineers, contractors, and subcontractors. Despite the rise of 3D BIM, the industry still relies on communication via 2D screenshots, email descriptions of issues, screen sharing, and other methods that lead to miscommunication and information loss.

This information loss manifests itself as RFIs, change orders, rework, and wasted time. With virtual reality, project teams can immerse themselves in full-scale versions of their BIM to identify and address issues while they’re still virtual and easy to update. Like joining a Zoom or GoTo meeting, project teams can use InsiteVR to virtually meet inside their models and prevent information translation and loss.

There are several major use cases throughout the project life cycle where multiple parties benefit from reviewing the model together at full scale:

- Coordination meetings
- Maintenance accessibility review
- Clash resolution discussions
- Site logistics and training
- Design review
- Constructability review
As demonstrated by the MacLeamy curve below, the sooner all project stakeholders can discover and address potential issues the cheaper it is to fix them. Without leaving their office, an architect and contractor can meet in VR together to make sure there aren’t missing details in the model or to address potential constructability issues.

VR isn’t just for impressing clients, the majority of the ROI is going to come from the impact is has on communication and late stage issue prevention.

![MacLeamy Curve](image.png)

**Do the Math – Are VR Meetings Worth It?**

On average an RFI costs approximately $1,080 and each takes about 8 hours to review. This doesn’t include the downstream delays incurred by waiting for the RFI to be resolved or the cost of any resulting change orders.

If teams can prevent at least 1 RFI per VR meeting then in the 8 hours it takes to respond to a single RFI, you’d save the project $8,640 and 64 hours. Even if VR is employed later in the process then using it to decrease RFI resolution time can have significant cost and time savings. With the increasing accessibility of VR, justifying the investment in the technology isn’t hard.

**The Rise of Standalone VR**

Prior to 2019, most VR set ups required a PC, external sensors, and special desktop software to run. The effort required to use VR had relegated it to the occasional client presentation or to
only be used by projects where someone felt “comfortable” with the technology. It’s not something that projects could use on a daily basis because more time was spent struggling with the set up than actually being productive.

Standalone VR packs all the technology required for full-scale VR into a single device. With standalone VR there are no cables, no PC, and no external sensors required. In 60 seconds, a team can be immersed in full-scale BIM and can focus on important project issues rather than the technology itself.

Oculus Quest
In May of 2019, Facebook launched the Oculus Quest – a standalone headset with full 6 degree of freedom (DOF) head and controller tracking. This means that without any PC or external sensors you have a VR headset that tracks where your body and hands are in the real world. You can freely walk around large areas and that movement is reflected in a virtual environment.

The Quest is commercially available for $399 and everything you need comes inside the box. The accessibility and simplicity of the device make it an ideal candidate for teams looking to deploy collaborative VR because everyone can keep a Quest at their desk and join virtual review meetings in just a few seconds.

Enterprise Deployment
A device like the Oculus Quest is primed to be deployed at a larger scale. With PC based VR a large scale deployment meant firms had to coordinate three things: 1) procurement of VR-ready PCs 2) procurement of VR headsets 3) installation of VR sensors in conference rooms or VR areas.

With the Oculus Quest firms need only worry about a single device. It’s a device that can be rolled out across an entire office, region, firm, or project.

With upcoming tools from Facebook/Oculus it will also be possible to manage all Quest devices from a single dashboard making it the top contender in simplicity and robustness for an enterprise setting.

Read more about Oculus enterprise options: https://www.oculusforbusiness.com/

Limitations of Standalone VR
The portable nature of standalone VR does mean it has technical trade offs. Unlike a PC based VR headset, standalone devices won’t be running off of a high end GPU. Standalone VR devices rely on mobile based chipsets. An entire large federated data set can’t be loaded and rendered at once, but it can be reviewed in chunks. The mobile chipsets are also not suitable for
photorealistic rendering, which makes the Quest an ideal device for internal reviews and not for high end client presentations. There are tradeoffs to consider, but they can be easily mitigated with the appropriate workflows and software designed for standalone VR.

**Building the First VR Integration for BIM 360**

The InsiteVR and Autodesk BIM 360 integration is the first commercially available solution on Autodesk’s construction platform to allow customers to host group model reviews in VR. With the simple click of a button users can go from the BIM 360 web interface to a VR meeting. The workflow is optimized for use with multiple standalone devices like the Oculus Quest.

The InsiteVR BIM 360 integration allows teams to do the following:

- Review BIM 360 models in multi-user VR meetings with a single click from BIM 360
- Sync what’s seen in the BIM 360 web viewer directly to VR including camera position, hidden elements, and layers
- Flag issues using speech-to-text and sync directly from VR to BIM 360 issues

The integration has a lot of moving parts and the following is an overview of what is happening behind the scenes to make everything work.

**How to Go from BIM 360 to VR**

With InsiteVR, reviewing BIM 360 models with a project team in VR takes only 3 steps:

1. Open the model in BIM 360 docs
2. Press the “View in VR” button

3. Join the VR meeting with your project team

Defining Workflow Requirements
When InsiteVR developed its BIM 360 integration it sought to develop a simpler, integrated workflow for project teams to use VR with minimal effort and maximum value.

Collaboration and communication are the core of BIM 360 so it made a good candidate for building on top of. InsiteVR’s criteria for the perfect VR meeting solution for AEC are:

1. **VR so easy anyone can use it** — Because of all the prep work required to use VR teams can get discouraged from using it despite the benefits. *Anyone* should be able to put on a headset to review models without having to spend an hour getting ready.
2. **Data integrity** — Teams should always be looking at the most up to date version of their model with as much rich information as possible. There’s no point in discussing clashes in an outdated model.
3. **Actionable results** — If you join a VR meeting you should be finding and addressing issues that can cost the project time and money. Project teams should be able to easily track and follow up on these issues after the headset is off.
4. **Avoid extra work** — Whether it’s rework, exporting, sending each other files, or opening game engines like Unity, teams shouldn’t have to do more work to use VR.
The InsiteVR BIM 360 integration delivers an immersive communication layer on top of BIM 360 that helps teams deliver projects on time and on budget. With Forge, InsiteVR was able to build an integration that met the criteria above so that teams can collaborate in VR without thinking about it and focusing on what matters: the project.

Forge
The InsiteVR for BIM 360 integration uses several Forge APIs to provide a simple workflow for teams to review BIM 360 hosted models in a collaborative VR environment. InsiteVR leverages as much data from the Forge APIs as possible to remove the need for additional user input and let project teams focus on what matters: finding issues before it’s too late.

OAuth
To get started with the integration users must first authenticate their BIM 360 accounts so that InsiteVR can retrieve and publish data on their behalf.

Authentication with Forge is done via OAuth2, which allows for token-based authentication and authorization.
Data Management API
Once users are authenticated with BIM 360, InsiteVR is able to retrieve their project information using the Data Management API. The Data Management API provides information about their hubs, projects, and folders. This information is used by the InsiteVR web service to keep a live connection to BIM 360 projects.

Webhook API
The Webhook API allows the InsiteVR integration to listen to Forge Data Management events and receive notifications when they occur. This way InsiteVR can grab the latest version of a model right after it changes because InsiteVR servers are notified of the change via a webhook.

This API was critical for InsiteVR to meet its goal of not requiring any user input whenever models were updated. Instead data is instantly synced whenever a new model is published to BIM 360 so teams can have VR meetings without having to think about model prep beforehand.

BIM 360 API
The BIM 360 API is used to push new BIM 360 issues directly from within VR. Users can use InsiteVR’s speech-to-text annotations to flag issues as they’re discovered and then have them transcribed into text. The transcribed text is then pushed back to BIM 360 issues to ensure actionable results from VR using BIM 360’s robust issue tracking tools.
With the BIM 360 API, InsiteVR could help customers document and track the results of VR meetings to maximize productivity.

Read more about the Forge BIM 360 API: https://forge.autodesk.com/en/docs/bim360/v1/overview/introduction/

Model Derivative API
The model derivative API enables InsiteVR to deliver models from BIM 360 directly into VR. Not only does the Model Derivative API provide the necessary geometry to render it also provides metadata that is useful to review issues in more detail. With the Model Derivative API, InsiteVR supports over 60 different file formats.

Since 2015, InsiteVR has been building native plugins for Navisworks and Revit to extract geometry and data for VR review. However, the Forge APIs provide access to information at a significantly faster rate than the native SDKs.

Read more about the Forge Model Derivative API: https://forge.autodesk.com/en/docs/model-derivative/v2/developers_guide/overview/
Read more about InsiteVR’s use of Forge: https://forge.autodesk.com/blog/customer-story-insitevr

Unity
Once InsiteVR servers have processed all the necessary geometry, BIM, and project data it is sent to the VR application clients which are built using the Unity engine. With Unity, InsiteVR has been able to build a multi-user VR application which runs on various platforms including: Oculus Quest, Oculus Go, Oculus Rift, HTC Vive, Windows Mixed Reality, and desktops.

When the “View in VR” button is pressed in BIM 360, InsiteVR streams data that is optimized for VR directly to the Unity VR clients. All data is optimized and cached on InsiteVR servers to minimize sync times between BIM 360 and VR. Data can be fetched directly from Forge, but to maintain a comfortable VR framerate InsiteVR has a pipeline to optimize geometry for VR.

Although InsiteVR uses Unity to develop its applications, users don’t have to directly interface with the Unity game engine themselves. Teams can have VR directly from BIM 360 without any additional programming, compiling, or model prep.

BIM 360
All the technical components described to this point have been mostly powering the back end of InsiteVR. Fetching, processing, streaming, and rendering data happen using a combination of InsiteVR, Forge, and Unity. So how can BIM 360 customers take advantage of this powerful tech stack?

InsiteVR sought to simplify the workflow as much as possible and integrate closely with BIM 360 so a button was added directly to the BIM 360 model viewer.

InsiteVR consolidated all the hard work of processing data, putting it in a game engine, and hosting a VR meeting into a single button.

No official API exists for extending the functionality of the BIM 360 viewer so InsiteVR developed a chrome extension to add this button at runtime. The Chrome extension is a Javascript based program which interfaces with the Large Model Viewer (LMV) that the BIM 360 viewer is built on. The extension allows InsiteVR to fetch information like camera position and viewer state to reflect the same view in VR.

The button allows project teams to seamlessly transition from a traditional meeting to a VR meeting when necessary.
Putting It All Together: Results with InsiteVR & BIM 360

The InsiteVR integration is the first of its kind and leverages several Forge services to deliver a seamless way for project teams to review their models together in VR.

With simplified workflows and standalone VR software, collaborative virtual reality can help project teams reduce late stage issues without requiring an in-house development team.

BIM 360 customers around the world are using the InsiteVR workflow to reduce RFIs, improve maintenance accessibility, and decrease design sign off times. From hospitals to office buildings, projects hosted on BIM 360 can use InsiteVR to leverage BIM assets in new ways. The shared workspace created by BIM 360 can be extended to new dimensions that unlock better communication, more confidence, and improved coordination.

To learn more about InsiteVR visit: www.insitevr.com
To learn more about the InsiteVR BIM 360 integration visit: www.insitevr.com/bim-360
Read customer case studies and InsiteVR updates at: blog.insitevr.com