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Save Every Dime: Use the Right Virtual Reality at the Right Time

Viveka Devadas
Autodesk

Learning Objectives

1. Learn how to quickly assemble VR visualization experiences and empower teams of AEC developers to work proactively and take effective decisions
2. Learn how designers can solve design issues and save on costs and use the right VR at the right time
3. Learn how to build interactive AEC models with smooth BIM data imports
4. Gain an understanding of workflows and resources available for project visualization and creating presentation deliverables

Description

There's a virtual reality (VR) solution for anyone in the construction business—big or small!

Architects and construction managers are under tremendous pressure to make effective decisions in professional practice and design and develop complex spatial experiences that are simultaneously appropriate, accurate, and cost-effective. XR (VR, AR, MR) solutions are vital in supporting effective design decision making, collaboration, and communications, and have the potential to revolutionize 21st-century architectural practice.

This session will include a demo on how to use the right VR at the right time. We will have an overview of how architects and designers can save incredibly on costs and use the right VR technology at the right time during the design process in their workflows.

Come and see sample workflows demonstrating how some firms use these technologies as design tools, marketing tools, and virtual mockups, as well as for interactive models, and how they conduct virtual design VR meetings in the cloud.

Viveka Devadas

Viveka is a Premium Support Specialist for AEC products and Generative Design-BIM at Autodesk. She helps in troubleshooting customer issues with AEC applications, networks with the global Autodesk team, and the Revit community worldwide through Autodesk's social media accounts and interacts and the Autodesk Revit forums. With a background in Digital Architectural Design and Construction Management, she has 9+ years of experience in the AEC industry as an Design Architect, BIM Manager, Social Media Coordinator and EU exchange Scholar. She is passionate about VR/AR technology and explores design challenges that are environment-friendly and cost-effective while analyzing how we connect with people, information, and experiences.

What is VR/ AR/ MR/ XR?

- **Virtual Reality (VR)**

VR is experiencing a computer-simulated environment through a **head-mounted display**, often referred to as HMD's that generate realistic sounds and images. VR replaces the real world with a simulated one in 3D, without the boundaries of a computer/ TV screen. Whatever way you look, the screen mounted to your face follows you. A system called 6DoF (six degrees of freedom) plots your head in terms of your X, Y, and Z-axis

Example: With VR, you can experience a simulation of a building interior you've designed—with people walking, equipment running—all before it's all built.

- **Augmented Reality (AR)**

AR relies on a device (a phone or tablet) a layer on top of existing reality, adds digital elements to the real world, and projects them onto your line of sight. Using AR, workers can view an **overlay of 3D models** and project information at a job site. Augmented reality is the blending of interactive digital elements – like dazzling visual overlays, buzzy haptic feedback, or other sensory projections – into our real-world environments.

Example: If you experienced the hubbub of Pokemon Go, Snapchat filters, you witnessed augmented reality in action. In short, it merges the real and virtual worlds and allows them to interact with each other in real-time.

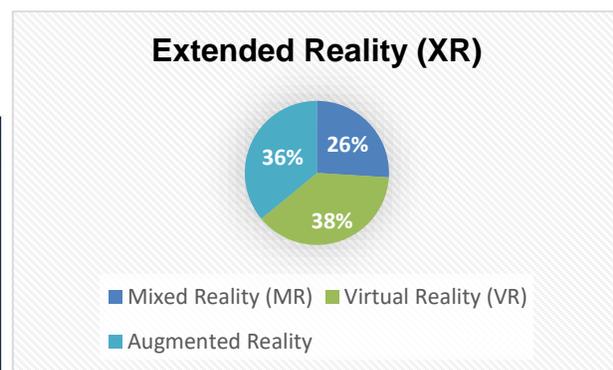
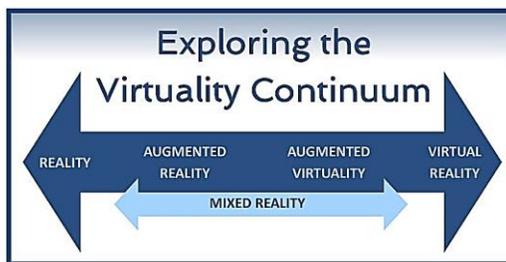
- **Mixed Reality (MR)**

MR is a **hybrid** of virtual reality and augmented reality, overlays interactive content.

Example: Using MR, you can touch a real table and use it as an interface to manipulate a digital model. Spectator view app by Microsoft for HoloLens

- **Extended Reality (XR)**

Extended reality (XR) is an emerging umbrella term referring to all real-and-virtual combined environments and human-machine interactions generated by computer technology and wearables. It fuses representative forms such as augmented reality (AR), mixed reality (MR), and virtual reality (VR), and the areas interpolated among them. XR is a superset which includes the **entire spectrum** from "the complete real" to "the complete virtual" in the concept of **reality–virtuality continuum**



What are the core challenges faced by the AEC industry today?

- **In-effective decisions:**

A disconnect between the digital information available to us and the physical environment we live, resulting in an inability to apply this data responsibly.

- **Communication gap:**

Insufficient communications from project design to delivery
Insufficient progress reporting during all construction phases
Instable performance management or monitoring, work process stoppages

- **Collaboration issues:**

Inaccurate short-term planning and missed connection to actual progress.
Project risk-managed insufficiently, **constant budget** extensions

- **Lack of Spatial experiences:**

Reality is four-dimensional, but the data that we must convey our decisions to clients remains restrained in 2-dimensions and limited to screens and blueprint inaccuracies

What value does VR provide?

Immersive computing is revolutionizing the world around us. Immersive visualization is a game-changer for architects and all AEC professionals. What started as a spark of imagination decades ago has ignited an inferno of technology-driven creative opportunity today. VR applications are very popular in the entertainment and gaming industry.

Most of these applications are created using game engine platforms such as Unity and Unreal. Gaming studios and M&E industry, in general, have developed many applications and solutions for VR. But we see an increasing demand from the **AEC industry**, and it is an opportunity for growth.

AEC teams are using gaming engines to showcase their projects and to immerse their clients, end-users, and Building Team members in highly detailed, fully lit environments that simulate the final structure. To capitalize on VR tech, you have to keep moving forward and address challenges.

Immersive visualization **provides value** as follows:

- Experiential – Enable stakeholders to see and experience your design
- Powerful – Validate design decisions and check for errors before construction
- Full scale – See the details or just the big picture
- Real-time – Make changes in your BIM model and see those changes reflected in your visualization
- Interactive – Animate objects in your design to make the experience more realistic
- Immersive – Deliver a powerful presentation experience for clients and stakeholders
- Intuitive – Simple to use and easy to understand

How does VR solve these challenges in design?

Here's how we can solve while discussing **top five reasons** why you should use VR for AEC

- **Effective decision making** - used as a **Research and Design Tool**

- **Understand design, boost productivity**

- Gain a better understanding of the impacts of your design decisions and problem solve and make quick iterations faster.
 - Understand how the position and height of the windows will affect natural light within the space, or easily adjust the position of the staircase to improve accessibility.
 - You can experience your changes in context and at full scale to confidently validate your decisions, before moving to construction.
 - You'll find yourself making better decisions that lead to better outcomes in less time, enabling you to increase productivity and client satisfaction by confidently arriving at the right design decisions.

- **Enhanced Communication**— used as a **Marketing Tool**

- **Get instant access, on your schedule**

- Visualization technologies are accessible to any architect, no matter the skill level. The tools are simple, intuitive and do not require a lot of training.
 - With instant access, you can quickly turn your BIM model into an immersive visualization as often as needed, without requiring the help of a visual design specialist.
 - No more waiting, and no more tapping into your budget for visualization specialist fees for everyday VR and if you need a highly-polished visualization, easily pass your visualization to a specialist who can enhance and refine the model using more advanced tools.

- **Custom Spatial Experience** – used as a **Virtual Mockup Tool**

- **Design better buildings**

- Immersive visualization is an accessible, easy-to-use technology that turns 3D BIM (Building Information Modeling) models into engaging spatial experiences of design that participants can explore. These tools help architects to refine and reshape their design— from initial concept to final design review.

- **Experience your design**

- Immersive visualization helps you to explore and understand your design in ways that static renderings and pre-rendered walkthroughs cannot. When you can freely navigate a virtual walkthrough of your model without constraint, you can get a more realistic sense of scale and proportion and understand how future occupants will interact with your design.
 - When architects can step into their design to walk through space, validate changes, and understand the impact of their decisions, they can improve their design and improve client satisfaction by delivering a higher quality final product.

4. Proactive Collaboration – used for VR meetings

Engage your clients early

- Client expectations are changing. It's no longer as compelling to present a 3D model or a 2D rendering in a design review. Impress your clients by offering a specialized service with immersive visualization. Surpass their expectations, and wow them by taking your model from the desktop to a highly realistic VR experience.
- The client will be able to provide valuable feedback early in the process that you can incorporate into the final design.

Client Feedback

- When all of you—the architect, the engineer, the contractor, the owner—are in sync and together can provide critical feedback at the beginning of the design process, you can align expectations before you move into construction.
- Walk your project stakeholders through the entire design —and provide multiple views to give them a true sense of the space in the initial stages of design. Identify and address potential problems or find opportunities for improvements early on to avoid costly changes, rework, or delayed project schedules.
- Design review becomes more interactive and more intuitive with immersive visualization.

Wow your clients, Win more work!

- While not every stakeholder can understand a scaled-down model, they can certainly understand what they experience in VR at full scale and helping you to secure their confidence and their next project.
- Firms that are increasingly leveraging the latest in immersed technology solutions such as Virtual Reality (VR), want to optimize project delivery by breaking down communication barriers between design, engineering, and construction. Creating **an information-rich virtual 3D model of a project** to be experienced by clients and stakeholders can win you your next project with the same client.

5. Safety training– used as an Educational Tool

Fewer risks, safer workers!

- Every day, job sites change. What was safe yesterday may be dangerous today. Human error contributes to more than half of occupational incidents
- VR has the potential to provide a standard worker-safety training program for major benefits such as increased worker situational awareness of job hazards
- Fewer accidents possible by creating safer worksites through highly realistic virtual-reality scenarios for employee safety-training program.
- The VR-based safety training program can offer a safe working environment where users can effectively rehearse tasks with construction hazards and ultimately promote their abilities for hazard cognition and intervention.

What are the Autodesk applications available to customers to create Immersive experiences?

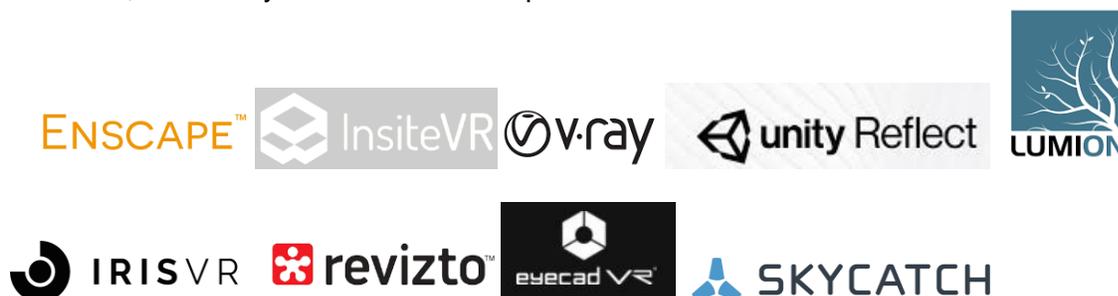
- Autodesk has some great solutions to deploy and share applications in a scalable way that provides performance speed
- Many tools offer a simple workflow from a 3D modeling tool, like Autodesk® Revit®, that serves as a hub of information to document everything from schematic massing to construction detail



- More products are available with the convergence of **multifunctionality**. The flexibility to move seamlessly between analog and digital, stitch it together, and you get a new thing.
- The interoperability between applications is possible, and interfaces are user-friendly and intuitive, and it's easy to integrate into the design process, also allowing additional infrastructure requirements
- Transform your design process. Step inside your design, learn how augmented reality and virtual reality technology (AR/VR) continues to deepen and expand its impact on the creative design process, especially in the world of AEC.
- For more than three decades, Autodesk has pushed the possibilities of what it means to create and helped our customers exploit the opportunities found in what's new and what's next.

What are the current VR technologies available?

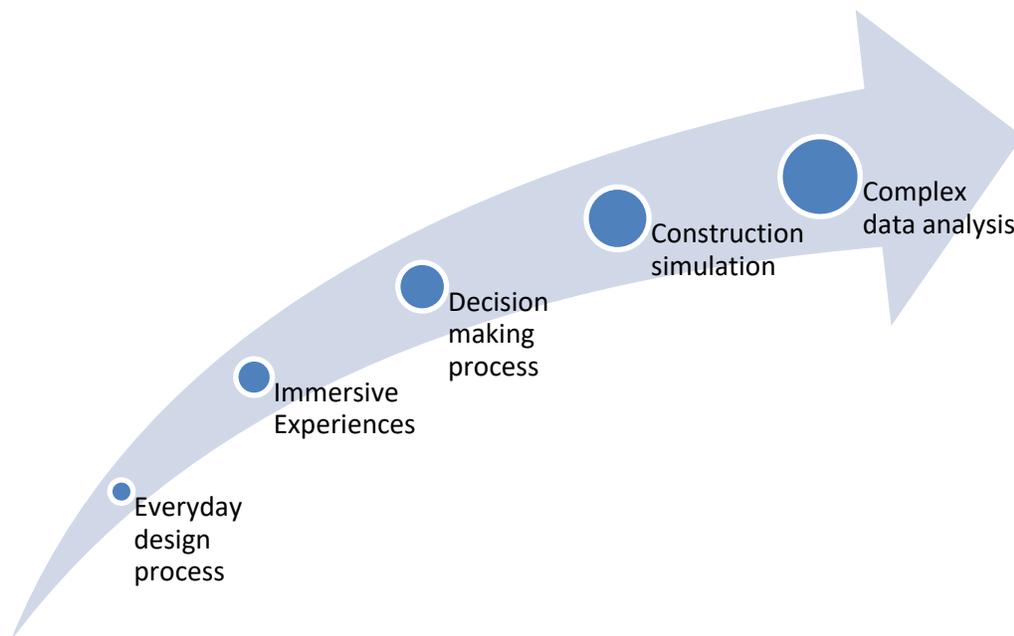
Many immersive visualization tools plug directly into your 3D model, providing fast, immersive access to the project design to anyone, at any time, and on any device. Leverage your existing BIM data, and take your visualization experience to full scale.



What goes into VR visualization experiences? Where do we start?

- Gather information, determine needs, research applications and costs involved
- Check, work out requirements – plan for stages, research hardware as you go
- Create/ Test software and hardware applications, “**try it before you buy it**” option
- Solve design problems, address challenges
- Execute design concepts, iterate – change it as you go!
- Save your design, optimize costs and add value to the overall project
- Good news is that there is tremendous future competition between VR headset manufacturers, software makers and hardware applications and the increasing popularity of the VR technology will force these prices to **decrease sharply**.

Examples of Virtual Reality workflows



Below are a **few use cases for virtual reality workflows** ranging from everyday design processes to complex data analysis.

1. Everyday design processes

- 360 stereo panoramas
- High profile realistic images, still renderings, concepts
- Initial visualization
- User Experiences of Project Designs VR for Client feedback

Example:

Company name: Starbucks Coffee, Tokyo, Japan

Process and techniques:

- High end 3D visualization and walkthrough of horseshoe-shaped Experience Bar
- Incorporate features expressing regional, historical contexts and the lifestyles of locals—in short, to appeal specifically to the Japanese market.
- Wanted to break free from standardized designs

Software applications used:

- Conventional 2D software, made the shift to BIM
- Autodesk® Revit®, Autodesk® Stingray, Autodesk® Revit® Live

Hardware applications used:

- VR HTC Vive head-mounted display.

Savings:

After 2011 earthquake and tsunami, require nursing care or have disabilities and cannot leave their homes. So, they embarked on trials to have telecommuters work in the shop-design team

This saves money by reducing the number of workers needed on projects and reducing delays and material waste.

Costs:

When remodeling an existing shop, the design team re-creates the original 2D plans as a 3D model to execute the additional design work. With access to this data, it became much easier to show colleagues on the business-operations side of the company—such as sales managers and district managers—how each shop would change. As a result, the team could significantly ramp up the pace of the design process, saving time and money.

2. Immersive Experiences

Head mounted devices

- 360 stereo panoramas
- High end visualization

Client demonstrations

- VR walkthroughs
- VR meetings – all stakeholders

Company name: Stantec, courtesy Robert Manna

Process and techniques:

- At Stantec, they don't have a separate VR team—it's the designers themselves who use the tool.
- This means clients can experience and review projects them directly with the project team.
- High end 3D visualization and walkthrough of models, high quality for client meetings
- Incorporate features expressing regional, historical contexts and the lifestyles of locals—in short, to appeal specifically to the Japanese market.
- Wanted to break free from standardized designs, no more wireframes

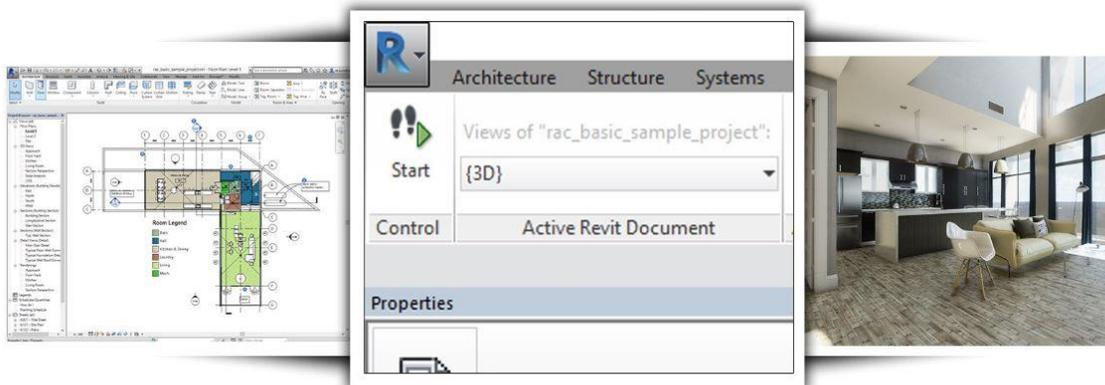
- Their focus is on Technology driven design that involves Disruptive thinking, Applied technology and Computational analysis.
- The teams consider Data to be the primary key to unlocking a project's full potential.
- They help clients realize the full potential of their project by harnessing the power of data-rich, model-based workflow to improve business operations.

Software applications used:

- Autodesk® Revit®,
- Enscape®,
- Insite VR
- Lumion is preferred not just for VR but for higher end visualization and being able to quickly slap in assets to dress a model up (people, plants, etc.)

Enscape™ is a key and very popular add-in for Revit and a workflow through to VR. Real-time rendering technology your project will impress from every angle, even at different times of day. There is a possibility to fly to the spots the client's like. It's fully dynamic and: A lot of fun!

Bonus points: Additionally, you can export the Enscape walkthrough into a Windows executable or a WebGL based website that we host for you.



START REVIT, SKETCHUP,
RHINO OR ARCHICAD

...and open your project

GO TO THE
ENSCAPE PLUGIN

...and press start

WALK THROUGH
YOUR PROJECT

...and amaze people

Stantec conducts **VR Meetings** for client deliverables **(using InSite VR)**

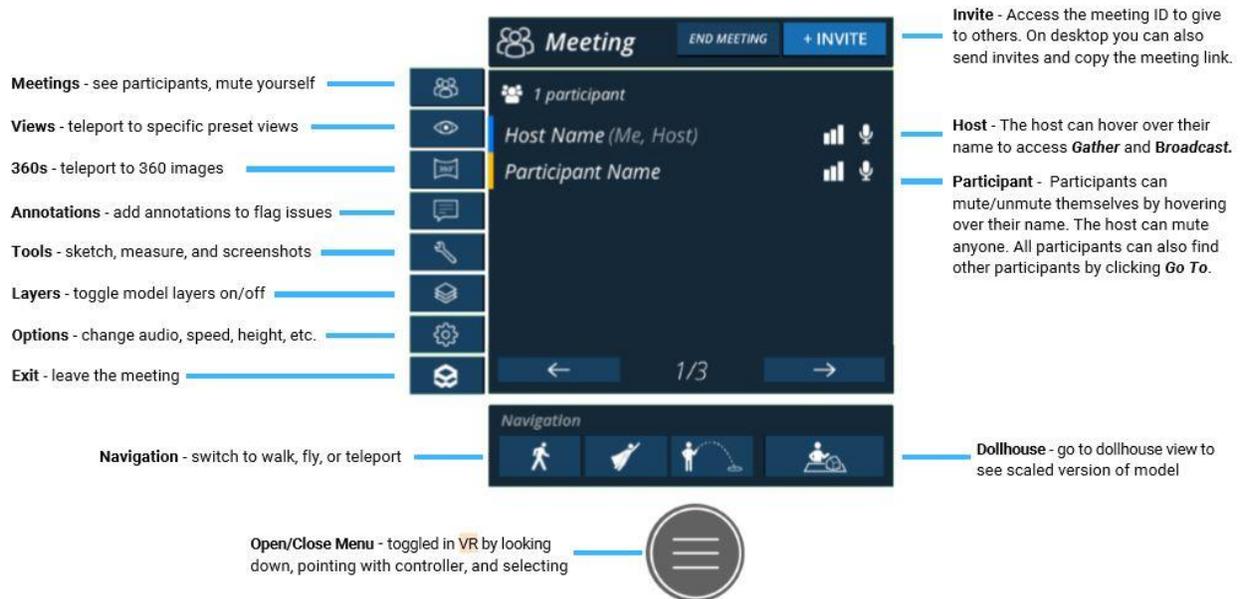
Insite VR - In the click of a button your model will be VR ready and synced to the Insite VR cloud for interactive participation in design review and coordination meetings.

- **Meeting agenda:** Before your meeting make sure you know what you're trying to accomplish by bringing the project team into VR. Exploring the entire model can be inefficient. Budget 15 to 20 minutes of your meeting to review specific issues or areas in VR.

- **Inviting participants:** After clicking Start VR Meeting or Invite you will see various ways to invite others to the meeting. Participants can join in these 2 ways: Meeting Link - click the link to join the meeting from a PC Meeting ID - enter the meeting ID from Oculus Go or a PC
- **Meeting management:** The meeting host is responsible for making sure the project team can efficiently review issues in VR. If this is the team's first time with VR set aside some time for training. During the meeting use tools like gather, broadcast, go to, and follow to aide team discussions.
- **Audio troubleshooting:** After joining a meeting, you will see a window to select your audio devices and test your audio. You can also test in the Options menu. If people are in the same room the host can mute all & mute participants by default.
- **Annotations and the PDF**

Use speech-to-text annotations to flag issues that are discovered. Insite VR auto-captures a screenshot of the annotation. After the meeting you can download an automatically generated PDF from the annotations menu so you can follow up on these items.

The InSiteVR **Menu** available in VR



Hardware applications used:

- Oculus Quest
- more highly portable headsets (google cardboard, headsets for Web VR)
- Mobile apps – Round me for panoramic tours



Costs and Savings: 70% savings of total project costs –faster adoption, and gain valuable customer insights eliminate waste, prevent errors, travel costs, minimize travel

Examples of Virtual Panoramic tours by Stantec:

Round me app: Virtual tours made simple, which is a hassle-free 360 VR publishing and panoramic tour authoring platform

1. **Educational:** St. John Paul II Catholic School
Faith, family, and 21st century learning come together in Grande Prairie’s latest catholic school.
<https://roundme.com/tour/299245/view/957083>
2. **Hospitality Campus:** SAIT Hospitality & Tourism Downtown Culinary Campus
This building has been created for the teaching of the business of restaurant ownership and entrepreneur development.
<https://roundme.com/tour/290212/view/913250/>
3. **Administrative:** San Ysidro Land Port of Entry
We’re helping the US General Services Administration realize their goal of a “Port of the Future” that is sustainable, operationally scalable, and has a reduced carbon footprint.
<https://roundme.com/tour/445626/view/1534217>

Stantec uses Enscape™ to **live link from BIM to virtual walkthroughs**

3. Decision Making Process

Company name: Layton construction

Example: Medical center in Florence, Alabama.

Process and techniques:

- Layton Construction, the company that designed the center, created realistic 3D models of the facility to let people walk around the medical wards. Layton’s Virtual Reality (VR) and Building Information Modeling (BIM) teams played a key role in the design, finding solutions in days, instead of months spent

- The focused more on in-house design team decisions (VR Transforms Doctors, Nurses, and Staff Into Virtual Construction Allies)
- As a result, over 200 people have explored the place. They have provided valuable feedback that allowed for important changes to be made.
- Layton discovered a New Way of Doing Things for effective decision-making processes
- The 263 new patient rooms were seen virtually before they were built physically. Hospital leadership had front-line employees tour the site and make suggestions before construction was completed.



- VR helped to determining where the best place to put electricity, even furniture.
- “The beauty is, when they find something they move over to the second station on the 3D model and they make the change right here.”



Software and Hardware applications

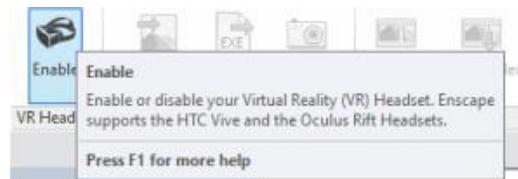
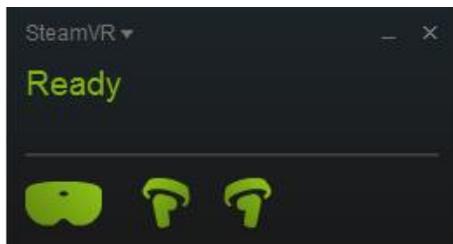
They used Revit® for model creation, Enscape™ for renderings. After the VR mockups were finished, they let the personnel of the center into the virtual center using **HTC VIVE system**. They could move freely around and interact with the environment.

Official HTC Vive and Vive Pro hardware requirements have to be compatible with the machine.

HTC Vive and Vive Pro

Setup

- In order to run Enscape with the HTC Vive / Vive Pro, you're required to have Steam, including SteamVR, installed and running. All required software will be installed by the official Vive Setup.
- Once installed SteamVR will guide you through all the setup steps needed to prepare your room scale VR experience (*Run Room Setup*).
- When SteamVR signals everything is green and ready to go, you can go ahead and enable Enscape's VR mode via the *Enable VR Headset* button in the Enscape ribbon.
- SteamVR indicates the headset and controllers are ready, enable VR mode in the Enscape ribbon.



Costs and Savings:

- They built physical mock-ups, contributing to **savings of over \$200,000**
- It's estimated that prefabrication **saved \$2 million in labor costs and shaved six months off the project's schedule.**
- North Alabama Medical Center (NAMC) is located in Florence, Alabama, a rural tri-state region, more than a two-hour drive to Memphis, Nashville or Birmingham. The remote region would require many times the number of skilled plumbers, pipe fitters, welders, electricians and certified medical gas installers than the local economy could supply to complete the 485,000 square-foot, **22½-month-scheduled project.**
- To make up the difference, prefabrication was determined to be essential to success. Alongside Layton, design-assist subcontractors with pre-fab experience detailed an assembly plan and schedule.

- Off-site warehouse assembly space was acquired, designs completed for many components in 20 different room types, and quantities resolved.
- **Layton's Virtual Reality (VR) and Building Information Modeling (BIM) teams played a key role in the design, finding solutions in days, instead of months spent**
- Each hospital was impacted differently, so repair work and costs incurred varies, with total costs likely to exceed millions
- Hospital (Plantation, FL), University Hospital (Tamarac, FL), Kendall Regional Medical Center (Miami, FL) and Aventura Hospital and Medical Center (Aventura, FL). Work to bring critical care areas back on line began immediately.
- This included repairing roof, exterior skin and window damage to drying the facilities. After getting initial concerns mitigated, work to systematically repair damage to patient rooms, operating rooms, building exteriors and landscaping, and dry and remediate inside water damage, while not disrupting ongoing hospital operations was phased through mid-2018.
- Due to the immense damage done in the region, and with a shortage of available construction labor, Layton has worked within its nationwide network to go outside of the state to bring in labor to insure the work is done timely and effectively.

4. Construction Simulation

- There is a need for construction simulation due to the complexity involved in processes leading to safety hazards and accidents.
- Two types of key simulations available in the construction industry
 - Network-based simulation (complex, more time consuming)
 - Graphic simulation technique (Visual interactive simulation)
- Provides safer training of construction workers
 - certain construction operations can be modelled, visualized in 3D and experienced in real-time 3D environments
 - clearing the site of debris
 - handling hazardous materials
 - moving building components like prefabricated walls, windows, structures
 - renovation
 - demolition
 - operation construction equipment such as cranes
- It is less expensive and much safer to train heavy-equipment workers – e.g., crane operators – in virtual reality.
- The thing is that many graduates don't have enough practice at a construction site.
- Here is where VR training comes into play. With its help, engineers and architects could get much more experience before graduation.
- Virtual reality enables multiple users to experience the equipment dynamics and kinematics before even actually operating an equipment in real life.

Example:

GE is equipping field technicians with cutting-edge augmented reality glasses, changing the way workers engage with the physical world by giving them handsfree access to information, or allowing remote experts to see exactly what the technicians see as they repair wind turbines.¹

- **Costs and Savings:**

- Benefit construction phase of any project by predicting the different kinds of issues that may arise and how they can be solved, saving millions.



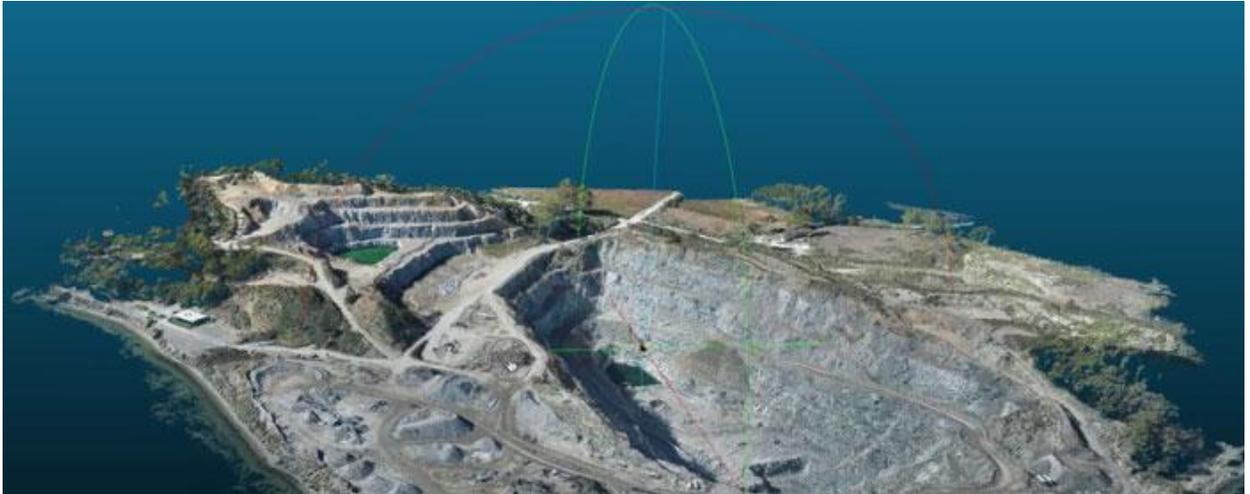
5. Complex Data Analysis

Company name: Komatsu Smart Construction, Japan

Process and techniques:

- Animation and Gamification of the AEC model
- Think of it as **drone-to-phone construction management**
- Virtual reality and augmented reality freeze data at a point in time, yet construction sites change constantly. **Superimposing drone-gathered site data onto the BIM model in real time** makes new technologies possible; Komatsu’s autonomous earth movers are just a first step.
- Skycatch’s drone and VR modeling. On a construction project in Japan, Skycatch found a problem on the first day of its use. Komatsu Smart Construction worked with San Francisco based start-up Skycatch to improve data collection and processing.
- In comparing its gathered imagery against the site model, the system found a \$400,000 misaligned concrete slab.
- Start-ups like Skycatch and Reconstruct and others are working from the drone-and-imagery side, while technology software companies are working from the design data side.
- If construction had been allowed to continue, the mistake easily could have ballooned construction costs depending on what phase of construction the problem became apparent.

- Now, whenever Komatsu Smart Construction vehicles are on site, they are guided by one or more drones gathering terrain data. Komatsu refers to the resulting workflow as the world's first machine-to-machine automated construction system.
- Skycatch's drones photograph job sites, capturing imagery and automatically generating 3D site data. The data can be quickly laid over site drawings or models to automatically calculate area and volume of earth to be moved.



- The results are transmitted as instructions to Smart Construction machinery for fully autonomous work on the site. Think of it as drone-to-phone construction management.

Cost and Savings:

- Lives are saved
- Essential tasks that once took days and often cost thousands of dollars to complete can now be done in hours at a fraction of the cost.
- Armed with the proper software and tools, a licensed drone pilot can bring efficiency and massive cost cutting throughout a project from pre-bid inspection to final completion.
 - **Surveying**
Consider the cost of a traditional site survey. For example, an 80-acre site with GPS points in a 50 x 50 grid would require approximately 1,600 GPS points. A survey team placing a point every three minutes would need 80 hours to complete the job.
 - **At a cost of \$150/hour, it would cost \$12,000** to complete the survey. It would take a two-man team working without break 80 hours just to place the GPS points. Add additional time for mapping, drawings or other data processing

Laser Scanning and BIM

One of the most precise methods is using laser scanning and BIM.

If compared to conventional survey measurement methods, laser scanning (also known as LIDAR or point cloud survey) provides better accuracy and is cheaper. Moreover, for a town and landscape topography, it is possible to conduct scanning at night when there's few to no people obstructing the surfaces.

LIDAR methods allow for more precise surveying of complex geometry and surfaces that are hard to access. And, all the major BIM software has built-in compatibility with point cloud survey data so that you can import it as 3D graphic material.

By combining laser scanning technology with drones, you can create highly detailed models for the virtual reality environment.

What is the future of VR and AR technology?

Statistics prove this fact: by **2022**, the market size of augmented and virtual reality is expected to surge – it will increase eightfold as compared to 2018, amounting to **\$209 billion**.

More than just cool technologies, Virtual Reality (VR), Augmented Reality (AR), and Mixed Reality (MR) are changing how we design, create and experience everything from factories, buildings, automobiles, to training, learning, and entertainment.

The technology comprises of a powerful toolkit for early stage design, weaving together building information modeling and visualization for compelling architectural designs and client presentations.

Reshaping the world of design

AR, VR, and MR represent both a disruption and an opportunity for people who make things. Using these technologies, you can transform 2D designs into interactive, immersive digital models, giving context to your digital information.

A new platform for content creation

With immersive design, engineers, designers, and builders can quickly and easily turn their CAD data into interactive, real-time experiences. AR, VR, and MR let you navigate data-rich design environments, so you can make better-informed decisions and create compelling experiences.

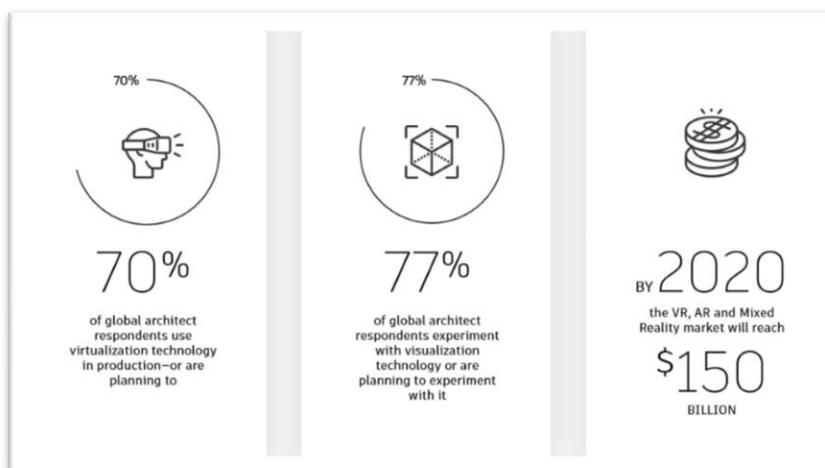
Why Every Organization Needs a VR/AR Strategy?

- How do you improve the way people work and live?
- Why should you adopt VR in your workflow— are you still on the fence?

We are entering a post-digital era where emerging technologies such as VR/AR are driving the next waves of innovation and growth. For the digital transformation to happen, the focus needs to shift from catering only to professionals to a broader base of decision-makers, influencers, and end-users. Every organization should stimulate research and discussion, safeguard and keep up with technological innovations. They should convene relevant experts act now, together, to proactively design, build and deploy tools and business models for a responsible future for XR while keeping in mind the physical, mental and social risks.

1. **Distance:** VR/AR technology helps address issues that are caused by remoteness and helps eliminate distance barriers
2. **Insights:** Obtains valuable insights with a more realistic view of their subject matter, which allows employees and leaders to make effective decisions.
3. **Training:** Safe training from conventional classrooms is available for those who need to practice in high-risk conditions, such as construction workers, military or chemists
4. **Data:** Seamless data access is available. XR removes distance barriers, and organizations can smoothly access remote data.
5. **Experience:** Delivers enhanced customer experiences, immersive tools are being used to augment workforce productivity

Visualization breakthroughs—like immersive visualization, virtual reality (VR), augmented reality (AR), and mixed reality (MR)—have become more democratized, and are now readily available to large and small businesses—including architecture firms.



Resources:

Autodesk

<https://www.autodesk.com/solutions/virtual-reality>
<https://www.autodesk.com/redshift/vr-construction/>

Wikipedia

https://en.wikipedia.org/wiki/Extended_reality

AECMag

<https://www.aecmag.com/59-features/1176-aligning-real-and-virtual-construction>
<https://jasoren.com/virtual-reality-in-construction/>

<https://www.autodesk.com/campaigns/immersive-visualization-aware/5-reasons-why-immersive-visualization-is-critical-to-designing-better-buildings-article>

Microsoft

<https://docs.microsoft.com/en-us/windows/mixed-reality/spectator-view>
<https://www.virtualiteach.com/single-post/2017/08/04/Exploring-the-Virtuality-Continuum-and-its-terminology>
<https://www.visualcapitalist.com/extended-reality-xr/>

Google cardboard

https://arvr.google.com/intl/en_uk/cardboard/get-cardboard/

Enable WebVR

<https://skarredghost.com/2018/04/25/how-to-enable-webvr-in-google-chrome/>

Unity

<https://unity.com/case-study/outhere-and-skanska>

Statistics

<https://www.statista.com/statistics/591181/global-augmented-virtual-reality-market-size/>
<https://newsroom.accenture.com/news/rapid-adoption-extended-reality-creates-urgent-need-for-responsible-design-and-deployment-immersive-technologies-according-to-accenture-report.htm>

Japan

<https://www.inc.com/suzanne-lucas/in-japan-working-from-home-is-a-government-support.html>
<https://www.aecmag.com/59-features/1176-aligning-real-and-virtual-construction>

Harvard Business Reviews

<https://hbr.org/2017/11/a-managers-guide-to-augmented-reality>

Stantec

<https://www.stantec.com/en/services/digital-practice/virtual-reality>

Layton construction

<https://whnt.com/2017/04/07/hospital-employees-tour-new-florence-facility-virtually/>
<http://www.laytoncompanies.com/news/north-alabama-medical-center-crossroads.htm>
https://www.timesdaily.com/news/local/virtual-reality-takes-staff-physicians-through-new-hospital/article_35bf3f54-1517-5c6d-945a-6372537e7434.html

Plugins

<https://eyecadvr.com/>

Enscape

<https://enscape3d.com/>

<https://enscape3d.com/knowledgebase/using-virtual-reality-headset/>

<https://enscape3d.com/how-to-boost-your-revit-presentation-with-enscape/>

Insite VR

<https://www.insitevr.com/>

HTC Vive with Enscape™

<https://enscape3d.com/knowledgebase/using-virtual-reality-headset/#vive>

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