Virtual and Augmented Reality Resolve Remote Collaboration Issues

WITH THE BREAKOUT success of Pokémon GO—crashed cars and cliff falls notwithstanding—it is perhaps unsurprising that augmented and virtual reality as portrayed in such Hollywood blockbusters as the films in the Iron Man franchise is making its appearance in the design world. Three design firms are among those currently working to develop software that would make it possible to use immersive technology to improve collaboration and communication with clients, the public, and members of the design team. While the three groups are working independently of one another, each is seeking to expand the use of virtual or augmented reality in the design realm and take it far beyond the visualization opportunities that gaming technology has already created.

The international structural engineering consulting firm Leslie E. Robertson Associates (LERA) is working to expand the uses of virtual reality in its design and modeling approaches, according to Antonio Rodriguez, a se-

nior associate in the firm's New York City office. (Rodriguez notes that while the effort is being developed in the New York City office, the technology is being embraced by LERA's offices in Mumbai, India; Shanghai, China; and Hong Kong.)

"We use virtual reality during concept phase to help the design team

The architecture firm NBBJ and the technology firm Visual Vocal are creating an asynchronous virtual reality communication tool accessible by smartphone that will track where a person is looking within an image so that audio messages about design elements can be shared and comments gathered.

visualize multiple design options," Rodriguez says. "We are able to know and visualize the design options by themselves but also provide context to them by, for example, locating a building model within a virtual

Virtual reality can be portable and universally accessible. Indeed, users need only attach small portable glasses to their smartphones.
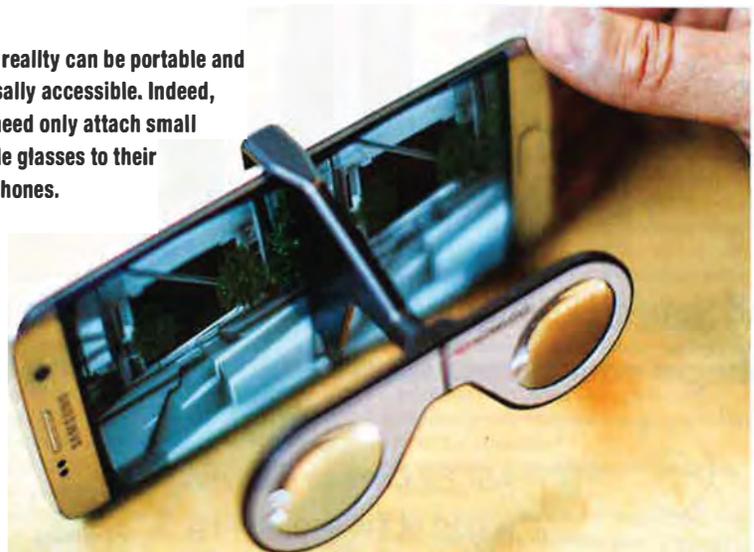
representation of the site and even to surrounding buildings—and in some cases we've included entire cities, like, for example, the entirety of Manhattan," Rodriguez says. "This allows the designer to experience a building which doesn't exist yet, including the dimensions, the feel of the spaces, and how to move through the building and its different views and lines of sight at a very early stage " he says. "So we beli ve—and we've seen this happen—that when virtual reality is used correctly, it's a very powerful tool for the design team and owners to get an enhanced level of information that allows them to make appropriate decisions in a timely manner."

To use virtual reality as part of the design process, such 3-D designs of a structure as those created with building information modeling are needed. In addition to these models, the computational expertise to create the virtual reality environment is of paramount importance, Rodriguez explains. This extends from making the controllers intuitive for first-time users to creating a virtual reality environment in which movement feels both natural and safe to people wearing the requisite headsets. LERA's design team, for example, has found that models that enable users to use their virtual reality controllers while sitting in a swiveling desk chair or standing in an empty room create a more comfortable experience for users.

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The portability of virtual reality systems depends upon the hardware used. While powerful smartphones offer the most portability, high-end computer equipment offers the least, Rodriguez points out. There are trade-offs at both ends of this spectrum, of course, as the amount of computational power used to create the virtual environment directly affects the quality of that environment.

Using virtual or augmented reality to create models that people can view at various stages in the design process is certainly not the end of the tech-assisted reality story. The global architecture and design firm NBBJ has announced a partnership with and investment in Visual Vocal, a technology start-up that will be incubated within the design firm's Seattle office. The partnership's goal is to create an asynchronous communication tool accessible by smartphones that would enable designers to ask questions and collect comments from just a few to hundreds of people at a time, making it possible to receive, compile, and annotate public feedback on particular design elements within a virtual reality model.

"We are not using [virtual reality] simply for high-fidelity rendering or visualization, but we are using the tool to better understand decision making around a wide range of topics.

So it's a productivity tool," says Steve McConnell, FAIA, the managing partner of NBBJ.

"We want to identify a fundamentally new human communication pattern around what we're calling immersive conversations," explains John SanGiovanni, a cofounder of Visual Vocal and its chief executive officer. "People can actually talk in context, surrounded by a scene, that will provide variance and voting and voice in a really rich way."

With the hardware—which could be as simple as the Homido "mini" virtual reality glasses or the viewer Google Cardboard, both of which are moderately priced—smartphones may make it possible to view virtual environments on both large and small projects.

"Let's say with one of our tech clients we're going to do a new headquarters and, as you would imagine, with a millennial workforce, understanding their views, their opinions, their hopes, and {their} desires is very important," McConnell explains. "We could imagine a set of inquiries around personal work space desire—how people collaborate, how they want to meet, how they want to play, how they want to exist within the workplace," he says.

While such feedback can already be collected via computer and other methods, NBBJ and Visual Vocal's communications app would take it further. An

AECOM had an opportunity to test the augmented reality system it is working on with Trimble Navigation when it conducted the complex engineering of an undulating summerhouse for London's Serpentine Gallery.

email to download the app could be sent to every interested party, even if the number exceeded 1,000. "Our planning group would send them a set of challenges [embedded in a virtual model] that they would then respond to, and they could respond to it at home, at work, on the bus, on the train—wherever they want—and within a day or two, whatever the time horizon was, we would be able to collect and synthesize all that data and understand and make an informed set of recommendations and draw insights from that feedback," McConnell says.

The phone app ould also be used to supplement publi forums. "This would be a fantastic vehicle for people to go into an immersive virtual reality environment and experience a proposal, perhap a new waterfront park or a train line being constructed through an urban environment, and begin to comment," McConnell notes.

But creating a -D environment for feedback purposes succeeds only if the particular portion of the model being viewed can also be tracked, SanGiovanni points out. Visual Vocal is tying into a smartphone's accelerometer

and magnetometer to do this; thus, comments and ideas can be tied to the particular portion of the model being viewed, even without the use of a separate controller by the user.

In the augmented reality direction, the international architecture and engineering firm AECOM, which is headquartered in Los Angeles, is working with Trimble Navigation Limited, of Sunnyvale, California, to improve the design process itself. (Whereas virtual reality creates an independent and fully formed world, augmented reality overlays virtual elements on real ones so that both can be experienced simultaneously.)

Trimble Navigation is developing software capable of transferring existing building information modeling data into a Microsoft HoloLens headset so that designers could interact with an unbuilt structure, according to Chris Thorn, the emerging technology consultant and project coordinator of the HoloLens pilot in AECOM's London office, who wrote in response to written questions posed by *Civil Engineering*.

"The HoloLens headset is a self-contained computer with a powerful internal processor and storage device which allows completely wireless use via connection to cloud-based servers," Thorn explained. "The headset contains cameras which digitally map the real-world environment and then 'projects' the 3-D model into the user's frame of view." With cloud-based storage, participants in a meeting using the hardware could be located on different continents.

Participants with the headsets can position and rescale the models as they wish, explains Jon Leach, CEng, FIStructE, a director of AECOM and the technical practice group leader for buildings and places in the firm's London office. "You use hand gestures and finger pinches and you can grab the model and move it…. You can rescale it so you can walk around it at one-to-one, or you can reduce the model and put it on a table in front of you," Leach says.

This summer, the London office of AECOM was able to test the system as its personnel there performed the engineering design for a summerhouse

created for London's Serpentine Gallery by the architecture studio Barkow Leibinger, which has offices in Berlin and New York City. (See "Serpentine Gallery Celebrates 16 Years of Pavilions," www.asce.org/cemagazine.)

The 5.7 m deep, 8 m wide, and 3.9 m tall summerhouse in London was created with a thin (30 mm) steel frame clad in a stressed skin of bendable plywood 4 to 6 mm thick. The design is "in the round," according to the architects' design statement released by the gallery. "Standing free with all its sides visible, and conceived as a series of undulating structural bands, [the summerhouse] is reminiscent of a blind contour drawing—a drawing executed without lifting the pencil up from the paper and only looking at the subject," the statement reads.

"The main challenge with this [summerhouse] was actually dealing with the geometry of it," Leach explains. "We found it very challenging to check the model on the screen because there were just so many curves and so many layers that were close to

each other." This made the summerhouse an excellent pilot for AECOM and Trimble Navigation's work in augmented reality.

"This structure was a perfect test because it was impossible to check in any other way," Leach says. Using augmented reality, the design team was able to walk around and within the model, resizing it to explore every connection point to ensure that the design fitted together perfectly before fabrication began.

The development work done by AECOM and Trimble Navigation goes beyond checking complex connections and designs, however. The team is also working to develop software that would enable someone to easily create a sketch over the top of an augmented

reality model, something that is currently a time-consuming process. "You can't currently sketch creatively in 3-D very easily," Leach says. "People would rather take a piece of tracing paper and a felt pen and do a sketch…than spend an hour building a [software] model."

If there's one thing that all of the companies agree upon, it's that the use of immersive technology in the design process is valuable for visualization, but it goes much further than that.

"A lot of what we do as engineers and as designers is communicate, so anything that facilitates that communication and makes it more intuitive and fast and natural—it's a no-brainer," Rodriguez says.

—CATHERINE A. CARDNO, PH.D.