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WHITE PAPER / **ADVANCING WORKFORCES WITH SMART GLASSES**

AUGMENTED REALITY TECHNOLOGIES OFFER INDUSTRY-CHANGING APPLICATIONS

BY Zachary Wassenberg

Forget everything you remember about Google Glass. The wearable computer glasses — Google's first answer to hands-free internet communication — were a commercial failure when they were introduced in 2013. Today a new generation of smart glasses is emerging with the potential to enhance performance, increase productivity, improve safety and more.

Rarely does a product failure fuel the start of a new industry. But Google Glass didn't fail because it was a bad idea, or because the technology didn't work, or even because of the privacy and safety concerns it raised. Google Glass — the high-tech glasses that interfaced with the internet to add information to the wearer's field of vision — failed because it was a product without a purpose.

Since then, the technology community has found that purpose. Actually, it has found several, and the number of applications continues to grow. The latest models can be programmed to do everything from alerting construction workers about safety hazards to speeding evacuation efforts after a natural disaster. The world is rapidly advancing toward digital everything, from wristwatches to smart cities. Augmented reality is the platform by which the workforce can easy interact and communicate on this digital frontier.

Manufacturers, utilities, software companies and design firms are among the end users who have taken notice and begun to test how these smart glasses can be used to enhance performance and produce measurable productivity gains. And they are moving quickly. A March 2017 report from Research and Markets forecasts that the global market for smart glasses will grow from 150,000 unit shipments in 2016 to 22.8 million units a year by 2022. Over the same timeframe, the revenue generated by the sale of these devices is expected to grow from $138.6 million to $19.7 billion.

But smart glasses aren't for every application. If a handheld device or paper-based system is working, there may be no good reason to replace it. Smart glasses are finding their "sweet spot" in applications where workers need a safe hands-free, portable internet interface, or when workers in remote locations need to collaborate on detailed designs, troubleshoot operational issues or receive training on complex processes. A September 2016 Electric Power Research Institute technical report indicates that utilities, in particular, should monitor the applicable smart glasses products and, in the next few years adopters of the technology will be able to tap into significant improvements. This white paper explores some of the applications already available or waiting in the wings.

But first, it's important to define some terms. Because smart glasses technology is still in its infancy, the language used to describe it is still evolving. Today, these glasses fall into one of three categories:

Augmented Reality is a term describing technology that modifies a user's reality, generally in a visual aspect. Assisted and mixed reality are both forms of augmented reality technology.

Assisted Reality (AR) smart glasses deliver information through the glasses that augments the user's field of view. Most are monocular, displaying text or information to just one eye. Users typically use voice commands, a touchpad or handheld controls to interact with the smart glasses.

FIGURE 1: *There are a variety of technologies offering different proportions of reality vs. virtuality on the technology continuum.*

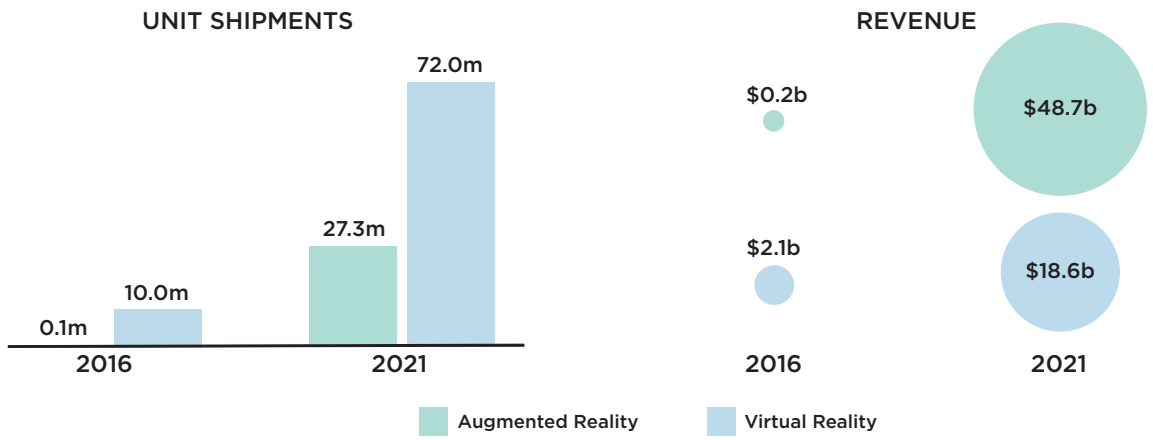

FIGURE 2: *Augmented reality could be a $50 billion opportunity when estimating worldwide virtual and augmented reality headset shipments and revenue. Source: IDC.*

Mixed Reality (MR) glasses and headsets are an advanced, more interactive version of AR glasses. The difference is MR glasses often offer binocular displays (i.e., information is displayed to both eyes) while allowing users to see their current environment. The term "mixed" comes from the blend of assisted and virtual reality. Most MR enables users to interact with their environment by scanning a room with 3-D sensors. Voice commands and handheld controls enable them to interact with the glasses.

Virtual Reality (VR) headsets are most familiar to consumers. This technology completely disconnects users from their environment, replacing it with a virtual environment. Users typically interact with this virtual world using handheld controls or physical movements, such as hand gestures and walking around. Still rarely used by many industries because of the high cost, VR solutions have been used to provide training to workers before they enter high-voltage or other dangerous conditions.

Prices for these units can vary markedly, with the simplest models currently costing up to $600. The most advanced MR and VR devices can run $5,000 a pair or more, depending on the application and software programming requirements. These prices, however, can be expected to drop as smart glasses gain more widespread use. Given the applications that are emerging, they may be worth every penny.

SAFETY: IMPROVING CONSTRUCTION ENVIRONMENTS

The current generation of safety glasses may someday be replaced with much smarter ones. Rather than simply protect the wearer's eyes, these glasses will feed workers real-time information designed to protect them against potential jobsite dangers. This adds a whole new dimension to safety.

Geofencing: Using Bluetooth beacons or GPS software, it is possible to build geofences that define a virtual geographic boundary. Transmitters then enable smart glasses and other devices to perform specific actions when in proximity to them. You've likely experienced a geofence if you have ever walked into a home or office where the lights turn on or off as you enter or leave an area.

On a construction site, geofencing can play an important safety role. If employees lacking the required safety clearance cross into a restricted area, for example, they can be alerted via a notification displayed on their smart glasses. The geofencing software can be programmed to map a safe exit route.

Should employees remain in or progress further into restricted areas, the technology can alert the project safety manager about the breach, identifying the offending workers and their current location.

Site Emergency Notifications: When an emergency occurs at a jobsite, best practices typically call for crew members to report to a defined place for a headcount. This process can be especially challenging on projects with hundreds of active workers dispersed over a large footprint. Some may need to navigate multiple safety hazards en route to the nearest gathering point.

Safety-enabled smart glasses, however, can alleviate many risks. A safety manager, for example, could send a mass emergency notification to each crew member's smart glasses. The devices would take it from there, identifying each crew member's precise location and all the pre-programmed safety hazards in the vicinity. The glasses can then direct the worker along a safe route to the nearest gathering location. Additional environmental applications can apply as well, such as identification of historical sites or wetlands.

A headcount itself could be completed instantly using the GPS data from each pair of smart glasses. Missing personnel could be tracked using the same GPS data, which emergency responders could use to locate and rescue them.

Applications like these will be most valuable if an entire crew is outfitted with safety-rated smart glasses. These "lower-end" glasses currently cost about $500 or more each, a significant investment. But prices are trending downward, and it is very possible these glasses may one day soon be as ubiquitous as hard hats on major construction sites.

DISASTER RECOVERY: SPEEDING EMERGENCY RESPONSE

When a hurricane, earthquake or other natural disaster strikes, even the most robust utility systems are vulnerable to outages. In these instances, smart glasses have the potential to be a true life saver, supporting efforts to quickly identify problems and coordinate recovery efforts.

Outage Identification: When a mass power outage occurs, utility employees typically are called upon to walk the lines and either mark or call in the locations of damage. Precious hours or days can be spent mobilizing repair teams that may only learn the true extent of the damage when they arrive at a site.

If those same employees walked those lines wearing smart glasses, the repair process could be transformed. Damage locations can then be documented with GPS-stamped photos and video taken by cameras in the glasses. These "smart" images can be sent instantly either to repair coordinators or disaster recovery software. The GPS data can then direct the next available repair team to the site, with the damage documentation providing the details needed to prepare for the repair.

Smart City Integration: During natural disasters, utility workers and first responders must be in constant communication to exchange up-to-the-minute information about utility damage, as well as dangerous and life-threatening situations. By tapping into the connectivity available through today's latest smart city technologies, smart glasses can be used to share vital information between city and utility employees, helping to increase both public safety and disaster recovery speed.

Smart city beacons and smartphone applications, in fact, could be used to crowdsource emergency data from the public directly. Traffic priority systems can be developed using GPS data that gives emergency responders the fastest route to their destinations.

In a major natural disaster like Hurricane Katrina, officials could use the glasses to coordinate evacuation efforts. The technology's hands-free route guidance capabilities could be tapped to direct public transportation vehicles to stranded residents who have used their smartphones to send distress signals or who have congregated in designated emergency gathering areas. And that is just the beginning.

PEER-TO-PEER COMMUNICATION: OPENING DOORS TO REMOTE COLLABORATION

Miscommunication on a construction project is one of the principal causes of schedule delays and cost overruns. It often occurs because traditional methods of communication — emails, video conferences and drawings — lack the immediacy and level of detail that an on-site, in-person visit can provide.

However, site visits aren't a perfect solution either. They can be expensive, especially if they involve travel and require significant — and often budget-busting — time commitment from senior-level staff. That's why smart glasses may be the communication solution the industry has been waiting for.

Office-to-Field Communication: Thanks to the point-of-view cameras built into some models of smart glasses, office and field crews now have the ability to experience virtual in-person communication without the expense of traveling to a job site. By video streaming a crew member's view of a design or construction concern directly to an engineer's computer or smart glasses, this technology allows the engineer to see exactly what the crew member sees. It makes it possible for the parties to discuss and resolve field design issues in real time. In addition to speeding the decision-making process, it can also help resolve potential RFIs, minimize errors and rework and, ultimately, increase project profitability.

Some of the more advanced MR smart glasses go even further. They enable a remote expert to mark up the field of view of a crew member's MR smart glasses. An experienced engineer could use this technology, for example, to point out and highlight critical details as a less experienced employee is walked through a new process on a video stream.

Office-to-Office Communication: Smart glasses can also be a benefit to organizations where design and project coordination require the participation of employees in more than one regional or remote office location. No longer must technical staff or project managers be limited to projects in their geographic location. Just as video calling has expanded patient access to medical experts in other parts of the world, smart glasses make it easier to bring together staff in remote locations to coordinate the details of complex designs.

Some MR smart glasses also have the potential to enable project reviews conducted using holograms. With this technology, team members in different locations would view a holographic 3-D project site placed in their room via MR smart glasses. Individual team members would have the ability to make and see others' marks on the hologram, while communicating using a video or conference call.

Still in its infancy, this technology will open the door to greater regional collaboration on design-build projects. It is projected by some to become a staple of interoffice work within the next five years.

CONSTRUCTION MANAGEMENT: HELPING PROJECTS RUN SMOOTHER

Construction sites can be fast-moving places. Even the most experienced construction managers can be slowed by the flood of paperwork. Equipment and materials can be misplaced, slowing progress. Smart glasses can address these issues and more, improving productivity and profitability in the process.

Material Check-In: Smart glasses can eliminate the paperwork associated with construction material check-in and management. This technology makes it possible to scan an arriving trucks' material list using preplaced QR labels or Bluetooth beacons. The digital checklist then can be automatically uploaded in the construction management software for processing, dramatically speeding the check-in process.

QR labels and Bluetooth beacons can also be used to manage equipment laydown areas. After a piece of equipment is checked in, for example, a crew member can bring it to a laydown area and rescan it using his or her smart glasses. Its GPS location is then labeled and stored in the construction management database. This process reduces material loss and helps crews locate poorly marked boxed items quickly. The same labels and beacons can be reused post-construction in the owner's asset management systems.

Project Progression: When integrated with construction management software such as Primavera, smart glasses can allow crew members to indicate start and completion times for individual assignments, adding in a 4-D time element and providing the contractors that follow them with up-to-the-minute information on when they can enter an area. When delays occur, the glasses can also be used to report revised completion date estimates. Managers can also track overall progress from a computer dashboard.

ASSET MANAGEMENT: IMPROVING MAINTENANCE AND EXTENDING EQUIPMENT LIFE

Gas lines can breakdown and catch fire. Pumps fail. Equipment of all kinds may at any given time be approaching the end of its useful design life. But in many utilities and industrial operations, asset condition is not documented and cataloged in ways that can help prevent future catastrophes. Thanks to a dramatic reduction in the cost of QR labels, Bluetooth beacons and RFID tags, smart glasses can perform these functions in a fraction of the time — and at a fraction of the cost — of traditional paper-based systems.

Asset Assessments: Smart glasses can be used to scan QR labels or interpret signals from preplaced sensors on individual pieces of equipment, adding asset data from inspections and transferring it to a database. Tags can also be placed on the data, indicating the level of urgency associated with any needed repair or replacement. A device on the verge of failure, for example, can be tagged for immediate replacement. Or a lineman wearing smart glasses might be alerted that a pole was in poor condition and slated for repair or replacement; he might defer climbing it because of the potential safety hazard.

Training: Onboarding of new employees responsible for critical asset maintenance can be costly and time-consuming. Smart glasses can be programmed to walk these employees through step-by-step maintenance processes. Utilities and other organizations can create photos and videos of standard methods and best practices that employees can access, via their smart glasses, to verify they are following the steps and processes correctly. Augmented training efforts like these not only reduce training costs, but also improve consistency and help avoid future rework.

WHAT'S NEXT?

These applications are just the tip of the proverbial iceberg. New opportunities and uses are being developed at a rapid pace as end users discover the still largely untapped safety value of a hands-free internet interface.

The new generation of smart glasses may still be in its infancy, but hold great promise in the electric, gas and construction industries. Adaption is expected to be brisk as prices drop and the productivity-, constructability- and safety-enhancing capabilities are more fully quantified. Already, progressive utilities, manufacturers, and design and construction firms have begun pilot programs to test promising new applications.

If your organization is interested, it may be time to try on a pair of smart glasses. You'll be amazed at what you might see.

BIOGRAPHY

ZACHARY WASSENBERG works in substations and augmented technologies, focusing on transmission and distribution engineer-procure-construction (EPC) projects. He spearheads investigation and implementation of augmented and virtual reality technologies in the utility and construction world. Zachary earned his bachelor's degree in electrical engineering at Kansas State University. He is a member of IEEE.

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