Microsoft HoloLens

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In recent years, the push to utilize technology has been advancing from one job to the next in the construction industry. The main benefits of technology have been increased precision and a more streamlined work process. For instance, with the utilization of BIM (Building Information Modeling) there is a higher work amount prior to start of construction, designers and subcontractors will build the system in the 3D model space leading to an increased understanding of overall system design. With the use of BIM, jobs have been able to increase in complexity because of the amount of coordination that goes into a project prior to construction. In areas of increased complexity trade workers can get the exact amount of material and know that there will be adequate space to install the required equipment, and if needed look at a 3D model for more complex piping routes to equipment.

From my time alone in the construction industry (about two years) I have seen an increased push for BIM in every job because of the streamlined approach that can be taken. With a model drawn by a skilled tradesperson the exact amount of material can be purchased leading to a decrease in unnecessary materials that are ordered. BIM allows contractors to also group jobs together once a bill of materials has been created leading to the ability to purchase materials of several jobs at one time and reduce cost. But most importantly it takes a burden off the trade workers to rely solely on their experience of different systems when an unusual problem arises that has already been resolved in a coordination meeting. BIM has led to an increase in safety on jobsites as well, for example using BIM and a total stations unit a worker can walk through a site and mark hanger locations on the floor above before the floor has been poured and another tradesman can follow and place hanger inserts so that drilling does not have to be performed overhead when pipe is being placed. BIM is beginning to come an essential portion of every general contractor and subcontractor's scope of work and the importance of this process will only increase from here.

As the industry has progressed from hand drawings to two-dimensional CAD models to now fully three-dimensional computer models with a high degree of precision where will the industry go next? The construction industry has grown to adapt current technology very quickly and the next likely transition will be to the use of augmented and virtual reality.

What's the difference between the two? Virtual reality is equivalent to being immersed in a Navisworks model and being able to move around only the space you have modeled and seeing nothing of the surroundings that you are currently in.

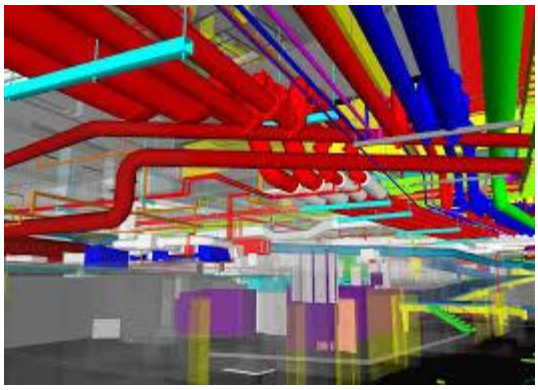

Figure 1: The Oculus Rift virtual reality glasses [1]. Figure 2: Example of Virtual Reality [2].

Augmented reality differs from virtual reality because it overlays the 3D model that you have on your computer with the physical space around you, the model appears in your glasses giving you the perception that you are looking at a hologram.

Figures 2&3: The Microsoft HoloLens augmented reality glasses with example [3].

The Microsoft HoloLens is a standalone computer meaning it can function just as any other computer can. When considering this technology in the construction industry the application that stands out as the most useful would be the Trimble SketchUp Viewer. This application involves a model being uploaded to a Trimble Connect (cloud based storage) account so that models can be directly downloaded and viewed in on the Microsoft HoloLens using the Trimble SketchUp Viewer application. On the application, the model can be opened and viewed in either full scale or a reduced scale desired by the user. This means that you can open the model produced for a job and view it in full size where ever you want.

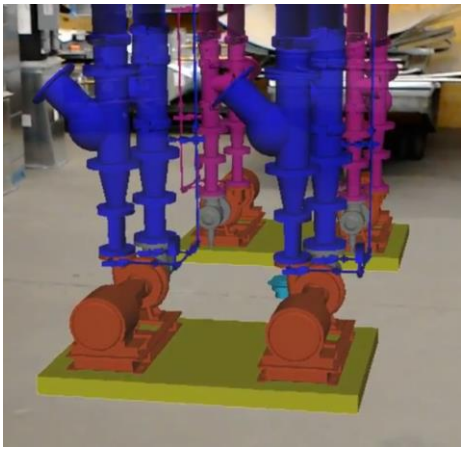

Figure 4: Example of HoloLens in use.

The potential use cases for augmented reality range from marketing to maintenance and operations. Beginning with marketing, the ability to demonstrate the use of technology a subcontractor can achieve can be extremely beneficial to both the owner and general contractor. Being one step ahead of the industry in technology can lead to increased productivity and a more reliable product. With the use of the Microsoft HoloLens the subcontractor can show previous models that have been developed to an owner looking for a qualified contractor to build. The accuracy of the models shown comes down to the quality of the original 3D model produced in either AutoCAD or REVIT. An owner knowing that a contractor has the ability to show a virtual model of what a blank space will look like once construction is complete is a benefit to both the owner and contractor because the construction team can ensure that what is being built is desired by the owner before construction is complete.

One of the most common uses for BIM currently is coordination meetings and sequencing of trades during construction. The Microsoft HoloLens and Trimble SketchUp Viewer application also offer increased use of this aspect of the construction process. The Trimble SketchUp Viewer can allow for collaboration between multiple people, even if they're not at the same place. A user simply attends a meeting on the app and are connected to other users across the country and can see exactly what each person is looking at because an outline of the attendees appears and a dotted line coming from them shows exactly what portion of the model is viewing. Holding coordination meetings in this application allows the users to be able to look in space and see potential issues, such as clearance or access to certain portions of their work. Sequencing of trades in these meetings is beneficial because the users are in the space looking at what is modeled to be built and seeing what trades work should logically come first in the process. Facility operations should be a primary concern of the construction team because the end goal is to produce a satisfactory building for the owner. During modeling of a mechanical equipment room, it would be useful to take the facilities manager on a virtual tour of a space that they will oversee maintaining. Each building is unique and the facilities manager can provide feedback to the construction team on placement equipment that require maintenance often so that valves can be accessed easier and proper maintenance can be performed.

The HoloLens has the potential to be a tool for quality control. Once a space is constructed a user can put on the goggles and load the model of that space and can view what was modeled compared to what was built. This gives the user the ability to see what was changed and allow them to see if there were any issues that arose during construction that were not thought of during the creation of the model. The user also has the opportunity to see if fittings were installed appropriately according to the model and ensure functional equipment. Punchlists at the end of construction could be improved by implementing the HoloLens. A list of tasks can be uploaded to Trimble Connect that allows the user to use the googles to see work that still needs attention in the space and address the issue that another user had previously noted. Some issues currently with the HoloLens use for punchlists are that the application can not load large models and use would be constrained to areas where there is the most work.

Figure 5: Virtual pipe passing through real hangers.

One of the first thing a user notices when looking at a mechanical space with the HoloLens is that it is clear when an object does not align with the model. This opens an opportunity to make as built drawings easier for the trade workers to complete. By putting on the glasses and immediately seeing how what they built differs from the model could streamline the as built process. Issues with this are that the trade worker would have to work back and forth from the glasses to the drawing that they are marking up on site. It would also be difficult to get an accurate as built drawing from the glasses as the model often shifts slightly during use.

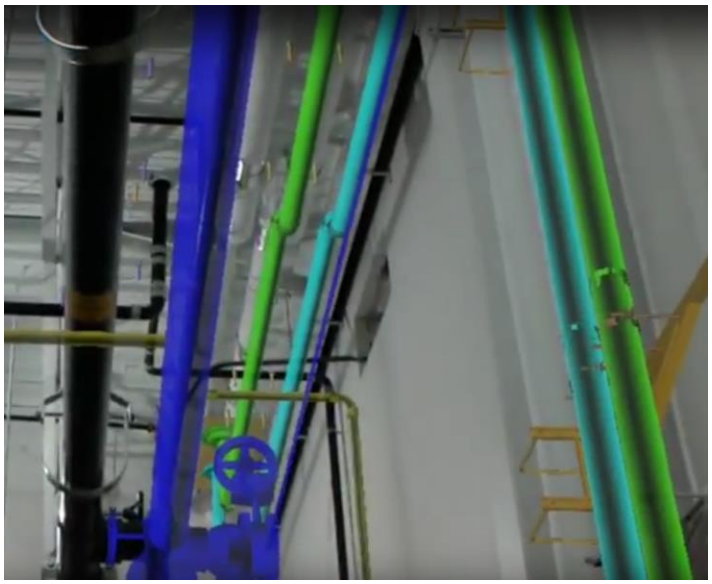

Figure 7: Difference of model to actual construction.

From a maintenance perspective, the HoloLens offers help to an operations manager. After construction, the model used could be turned over to the owner giving an operations manager the ability to see inside the walls and find pipes or duct runs that need attention for maintenance. Seeing the space used by mechanical equipment could be beneficial if the owner choses to remove a wall or add something to the wall because they could see what's behind the wall in a non-destructive way. Issues with this again would be that the size of the model is limited in the application and the user would likely have to break the model into useable pieces.

As with all new technology there are bugs and issues that need to be monitored when using the HoloLens on site. A primary concern is that it is impossible to wear a hard hat while wearing the HoloLens which would cause safety concerns when using this during construction. Model size poses a problem for a user, currently the Trimble Sketch-up Viewer only can handle models up to 10MB smoothly. Therefore, using the HoloLens for large spaces is not practical. Models also tend to drift off of the original location you place them, making it hard to get the sense for the modeled space or when comparing it in an as built stage. Technology progresses quickly however and we are in the first stages of the HoloLens. As more development is done with the HoloLens the technology will become cheaper and more applicable to use on a large scale in construction.