

How can virtual reality help construction engineers?

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Abstract

With virtual reality (VR), you can look and move around in a digital world. We wanted to know if VR could help construction engineers plan their projects. To find out, we set up an experiment where expert and novice engineers used either VR goggles or a normal desktop computer to review engineering designs in three

dimensions (3D). We found out that VR goggles made it easier for engineers to spot problems in construction plans. VR also helped engineers work out the order in which a project should be built. But VR has some limitations and should only be used for appropriate tasks and scenarios.

Introduction

Have you ever wished you could step inside a video game? **Virtual reality (VR)** lets you explore worlds inside your computer. VR works by connecting your actions to images shown on a screen. Airplane pilots use a kind of VR called flight simulators. They use controls that feel and look like real airplane controls, but the windows are computer screens. Doctors can use VR to practice surgeries. Parks and museums sometimes use VR to let people experience places that are too dangerous or too fragile for visitors. We wanted to know if VR could help **construction engineers**.

Construction engineers are responsible for making sure that the plans for building structures are exactly right before the project starts. They are responsible for making sure that the project is done safely.

The traditional method of reviewing construction plans is slow. Using VR, an engineer could move through a **3D digital plan for a construction project**, looking around

as if they were inside the structure. We thought that this might make the **construction design review** easier, faster, and more effective.



Participants in the experiment with VR goggles.

Methods

We set up a digital model of a complex chemical refinery. We wanted the experiment to be as close to reality as possible, so we worked closely with engineers who had built a real refinery. We built a digital version of an important part of the refinery, where gasoline is heated up and sent through a complicated series of pipes.

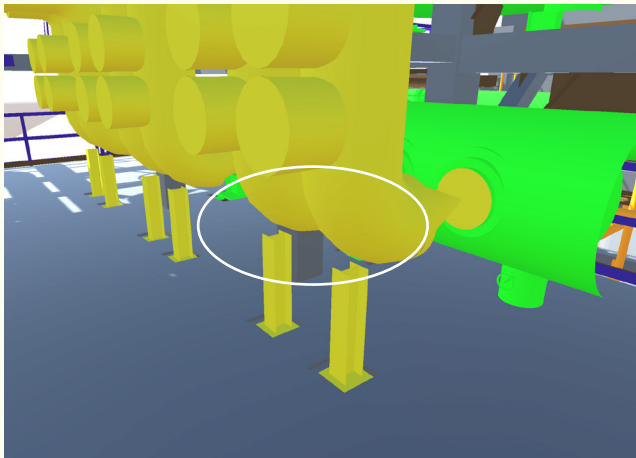
We recruited 48 construction engineers. Half of the participants had 3 or more years of experience (experts), and half were still graduate students (novices). We then randomly assigned some of the

engineers to explore the digital 3D model using a desktop computer. The rest explored the same model using a head-mounted VR goggles. We measured how well the participants did at 4 tasks:

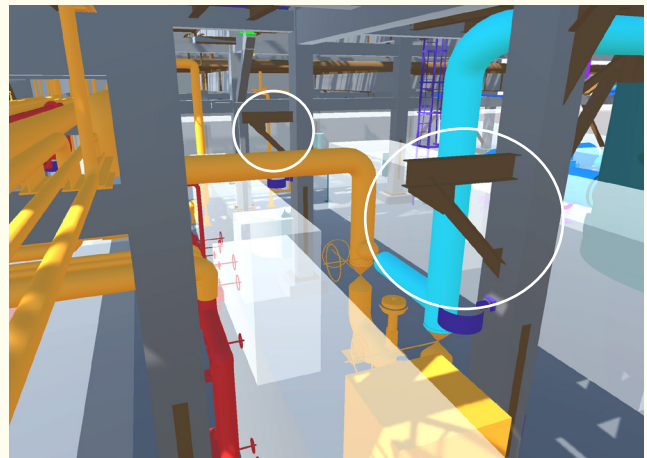
- Task 1: Finding mistakes in the design (Figure 1)
- Task 2: Planning the steps for construction
- Task 3: Checking plans for completeness
- Task 4: Recalling whether items were part of the design.

Figure 1:
Examples of design mistakes for the engineers to find.

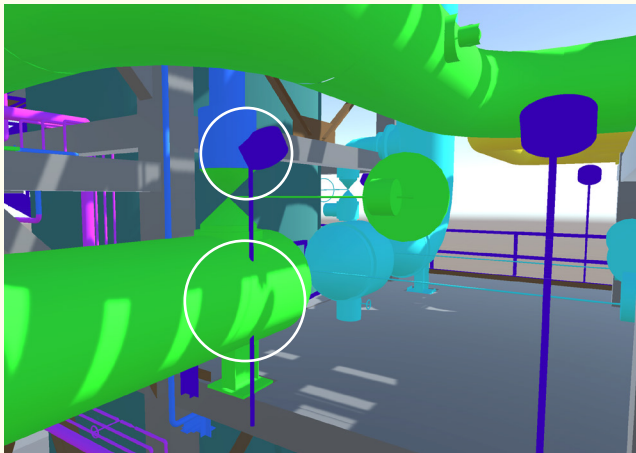
A) Supports that are too short.



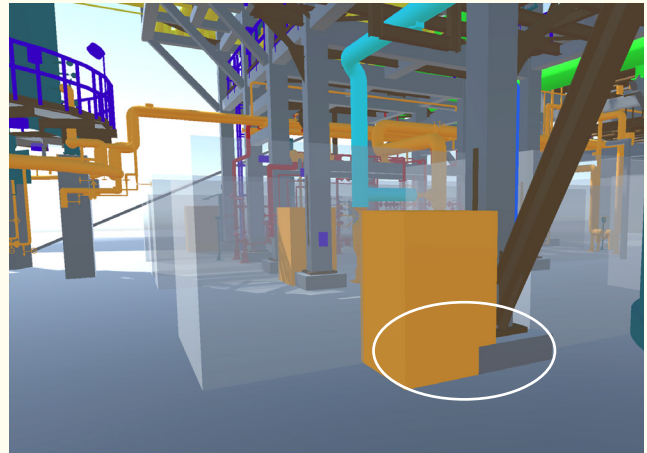
B) Supports that don't connect to anything.



C) A lamp in an impossible place.



D) Boxes overlapping each other



Results

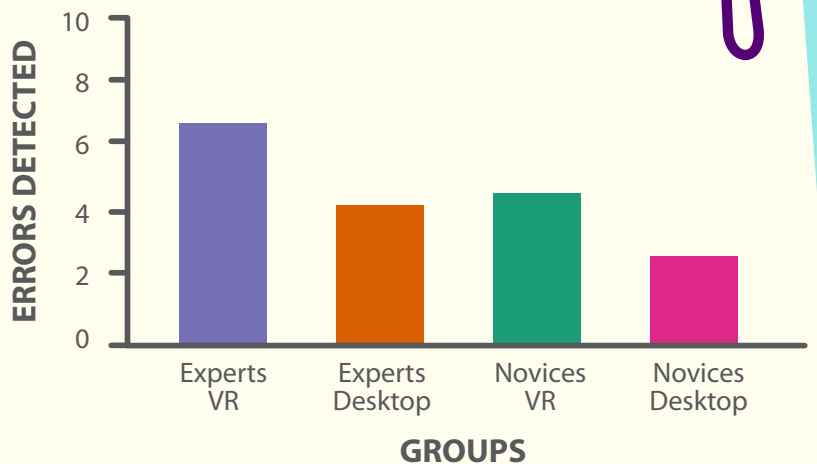
We compared the results of participants using VR goggles and those using desktop computers.

- Task 1: Both experts and novices who used VR goggles were better at spotting mistakes in the design (Figure 2)
- Task 2: The VR goggle-users also scored higher in planning the steps for construction.

Who was better at finding mistakes: engineers with VR goggles, or those with desktop computers?

Figure 2:

This graph shows the results for Task 1 (finding mistakes in the design). The height of the bar shows the average number of mistakes participants in each group found.



Discussion

Reviewing a construction design is a difficult task. Errors can be hard to spot. Participants with VR goggles were better at finding errors because they were able to look at the design from many angles. By virtually walking around the structure, they could see problems more easily. A bar supporting a pipe might be a few inches too short, and you wouldn't be able to see it until you got up close. Or a light fixture might be placed in an

impossible spot. With the goggles, participants could see a larger area at a time. Having a larger field of view also seemed to make it easier for participants to figure out the right order of steps for construction. Although VR did not seem to help engineers remember specific objects in the design, we believe more field research will help to explore this process.

Conclusion

It's exciting to think about ways to use new technologies. At the same time, it's important to make sure that the new technology actually makes things better. We found that there were several tasks where VR helped construction engineers to do their job more effectively. Construction engineering companies will benefit from using VR as part of the construction design review process. But before that

can happen, it needs to be easier to make digital models of construction designs.

VR is much less expensive than it used to be, and we think there are lots of interesting uses of VR that no one has thought of yet. Have you ever tried using VR headsets? What would you use virtual reality to do in your everyday life?

Glossary of Key Terms

3D – Three-dimensional, or something that has width, height and depth (length).

Virtual reality – A 3D digital environment in which a person can interact in a way that feels real, such as by wearing special goggles and/or gloves.

Construction engineer – A person who plans and manages the construction of buildings and structures.

Construction design review – The process of looking through the plans for a construction project to make sure there aren't any safety hazards or errors.

Refinery – A factory that purifies materials to make them more useful or valuable.

Field of View – The area you can see without moving your head.

Check your understanding

- 1 What does a construction engineer do?
- 2 How did virtual reality help the engineers?
- 3 What other uses of VR were mentioned in the article?
- 4 What do you think you could explore with VR at your school? How would VR improve your learning and understanding of a topic?

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