Design review using VR

Developments in the use of virtual reality (VR) technology enable designers to develop intricate simulation models, alongside the remote assessment of existing systems, like process plants, to troubleshoot operational bottlenecks.

By Luchelle Damons*

Typical engineering applications often see design work being done by hand and with appropriate software, usually in two dimensions (2D). Although designs are reviewed prior to the commencement of construction, design shortcomings can be overlooked, as reviews of 2D designs often lack the complete perspective that three dimensions (3D) offer.

An effective means of performing comprehensive design reviews throughout the project life cycle is required, in order for the design to be analysed from a holistic perspective. This would allow potential design challenges and possibilities for improvement to be identified and implemented in a time- and cost-effective manner.

The design, review and analysis of design alternatives form an integral part of any infrastructure delivery project. VR offers an innovative and effective way to perform the above-mentioned functions so as to ensure that the best possible infrastructure solution is ultimately implemented.

2D designs can be imported into VR software. Once in VR, the user is able to explore and interact with their design in 3D, in real time. VR incorporates tracking of natural head and hand interactions to simulate the feeling of immersion and navigation of the virtual space, as the user wears a head-mounted device and uses handheld controls.

Walking through the design

VR visualisation enables the various stakeholders involved in the infrastructure delivery project to explore, interrogate and interact with the design. These designs could include structures, P&ID (piping and instrumentation diagram) processes, plants, networks or systems. During the early project stages, the user is able to virtually 'walk' through the design and experience it as though construction has been completed.

If a model is visually interrogated from a virtual perspective in 3D prior to the

FIGURE 1 User analysing an engineering design using VR

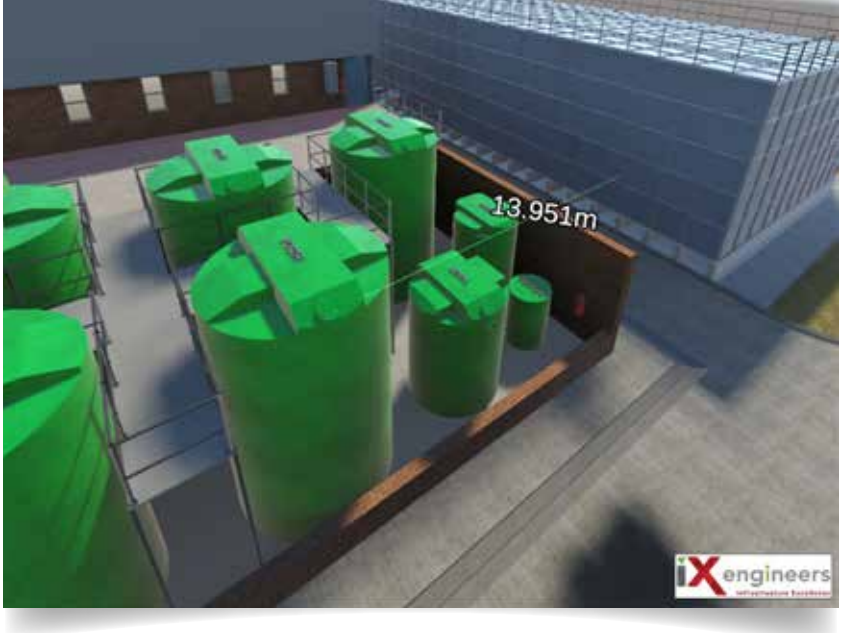

FIGURE 2 Realistic virtual renderings produced during the design phase of a project

commencement of construction, the design can be optimised. Since the virtual model is a 1:1 representation of the design, stakeholders will be able to gain a realistic perspective. They could then ascertain whether there are any components that are inaccessible, identify any obstructions, note any physical design errors (such as clashing pipes), pinpoint areas where working spaces need to be revisited, model and explore design alternatives, and identify where aesthetics are unappealing, among others.

VR advantages

If an error is identified as a result of design analysis through VR (as opposed to identifying the error during construction), the following will be avoided:

- time spent by the engineer verifying the error and formulating a design solution
- rework required, with associated abortive cost for the client, funder, contractor and engineer
- delays in construction programme.

Furthermore, using VR before construction commences, to demonstrate what the design will ultimately look like, ensures that all stakeholders holistically understand the project and can accurately anticipate the end result.

The benefit of using VR as a tool to analyse an engineering design can be derived throughout the project life cycle – not just during the design phases. In addition to being an effective visualisation tool, the virtual model can store information pertaining to the respective assets within the design. This information is known as building information modelling (BIM). For example, such information for a pump within a wastewater treatment works (WWTW) could include the pump's model, duty, efficiency, and service/maintenance information – any data the designer deems relevant.

Therefore, while the user is undergoing a VR immersion to visualise the design in 3D, they are also able to access this additional realm of information – the BIM data – without breaking immersion. This allows the designer to gain a more complete understanding of the project, as they can experience the physical components and access relevant data simultaneously, while they navigate the virtual space.

Furthermore, programmes such as Scada (supervisory control and data acquisition), can be incorporated into the virtual model to allow for the review and analysis of a new or existing plant to take place effectively. The Scada hardware and software gathers data on the actual performance of the various components within an operational development, which can then be accessed as BIM data in VR. Being able to receive updates on the actual performance of the development remotely, while simultaneously visualising every component of that development in 3D, through VR, enables effective system management and maintenance while the development is operational. To continue the example of the pump within the WWTW: the Scada information recorded could include the actual flows, velocities, pump efficiency, and more. If the data reveals that the pump is not operating as it should, the engineer will be able to identify the possible causes through interrogation of a 3D virtual model (and the embedded BIM data), as well as Scada information (relating to the actual operational data of the component). To illustrate: a sudden drop in pressure could be indicative of a burst pipe in a network, or a reduction in output volume could be the result of an upstream blockage – all of which can be determined remotely by the engineer using VR.

By performing design reviews and trouble-shooting operational problems using VR, time and money are saved during the design phases, while the development is operational, and right to the end of the component's operational life. While VR does not attempt to replace physical site visits, stakeholders can visit the site virtually without incurring the potential travel costs to and from site. In the same way, if a problem requires specialist input, the specialist can virtually visit the site repetitively to perform analysis, irrespective of geographical boundaries.

By incorporating VR into a project workflow, the engineer can design more efficient and well-thought-out developments, with reduced design, construction and operational costs. Work will be executed as though all stakeholders had foresight into how their designs will be translated into reality – with VR, that foresight is possible.

Through visualising and experiencing the VR model – from project initiation to the end of the operational life – engineers can better understand engineering problems. Ultimately, through the analysis of designs with VR, engineers become equipped to provide robust, holistic and innovative infrastructure solutions. 3S

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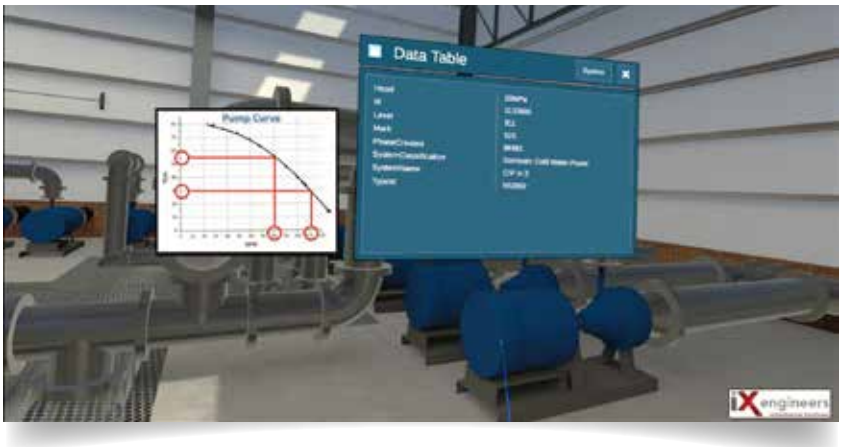

FIGURE 3 Complex engineering and operational data embedded within the virtual model as BIM