Ready for take-off?

When you think of disruptive technology within our industry it probably doesn't get any bigger than the use of virtual reality (VR) for operator training. For many the thought of qualifying someone on a virtual reality simulator is enough to keep them up at night. Fortunately - for these people - this is not currently possible, however things are moving at such a pace that it is not inconceivable that this might change in the not too distant future. We take a look at how the aviation industry has utilised the technology to great success and the potential benefits this might be offer our industry as well as review the latest developments to see if it can ever be more than just a tool for enhancing real-life training.

Could cutting edge flight simulators be used for operator training in the lifting industry?

Miracle on the Hudson

15.24 on 15th January 2009, US Airways flight 1549 is cleared for take off on a routine flight from LaGuardia Airport, New York, to Charlotte, North Carolina. Less than two minutes into the flight the plane strikes a flock of geese, causing both engines to fail. Captain Chelsey 'Sully' Sullenberger quickly determines that there is insufficient time, speed or altitude to return to LaGuardia or reach another airport, and prepares for an emergency landing on the Hudson River. Miraculously, Sully successfully completes a near impossible water landing, saving the lives of the 150 passengers and five crew members on board.

You may wonder what this has to do with VR training, but the reality is that trainee commercial pilots typically undertake up to 100 hours flight simulator - virtual reality - training to prepare themselves for such unlikely events. Yes, it is highly unlikely that Sully would have been trained for double engine failure *and* a water landing on a simulator, however he would have regularly and routinely rehearsed other crisis scenarios in order to learn how to deal with them in a calm and efficient manner.

Generally, pilots are also required to attend recurrent training each year to maintain their skills and qualifications, which often includes up to 10 hours in a flight simulator. Designed to provide them with the latest updates, practices and safety procedures, it is also used to review recent accidents or near misses. In fact the Hudson investigation included numerous simulations to confirm whether Sully had taken the right decision or not or if an alternative was possible. And you can be sure that airlines will have added similar simulation scenarios to their recurrent training so that flight crews are able to rehearse such eventualities.

The use of flight simulators in the aviation industry is a fully accepted method of training, and an obvious one at that given that it is the only way to experience and train pilots in a safe and controlled environment. But does the lifting industry warrant the use of this technology?

The benefits of VR

Operating a crane or a large aerial work platform may not be the same as piloting an aircraft, but there are many variables to deal with and should an operator make an error the results can be fatal. While you might laugh at any comparison of a crane or large platform operator with a commercial pilot, it is not as silly as it might sound. A good operator will carry out a thorough pre-use check of his machine, they will check the job plan, the timing and the weather conditions and forecasts, just as a pilot would, but without the same quality of information being available. You could argue that while we do not accept air accidents, we are prepared to accept crane or platform incidents, possibly because the chances of no one being hurt are lower than in a plane crash.

When it comes to VR training for equipment operators, cost, availability and a believable level of realism have all been detracting factors in the past. And while the VR technology available might not

*Flight 1549 after its emergency landing in the River Hudson*

be as cutting edge as in the aviation industry, the recent introductions of high quality graphics, fully immersive 360 degree vision, surround sound and motion technology have provided the necessary levels for it to become a credible training solution. Developers, such as Serious Labs, CM Labs and Tenstar have also spent many years improving courses specifically tailored for cranes, aerial lifts and telehandlers, which in turn, has finally led to training providers and associations to take note and start recognising the potential benefits.

Time to get serious

Canadian virtual reality developer Serious Labs has focused a good deal of its efforts on producing simulators and modules for aerial work platforms and cranes. As such, it is one of the few companies to develop a realistic work platform simulator with replica controls and a realistic motion base that accurately simulates the movement and response of a real platform. Launched in 2017 with a range of boom lift modules, it later worked with UK rental company Nationwide Platforms, Skyjack and IPAF to add a range of scissor lift modules. Earlier this year, it added a new aircraft inspection module to provide aviation maintenance crews with the virtual experience of operating boom and scissor lifts close to an aircraft without damaging it.

Darren Verschuren of Serious Labs said: "A 787-9 Dreamerliner costs $180 million. The cost of accidently knocking one with an access platform can easily run into hundreds
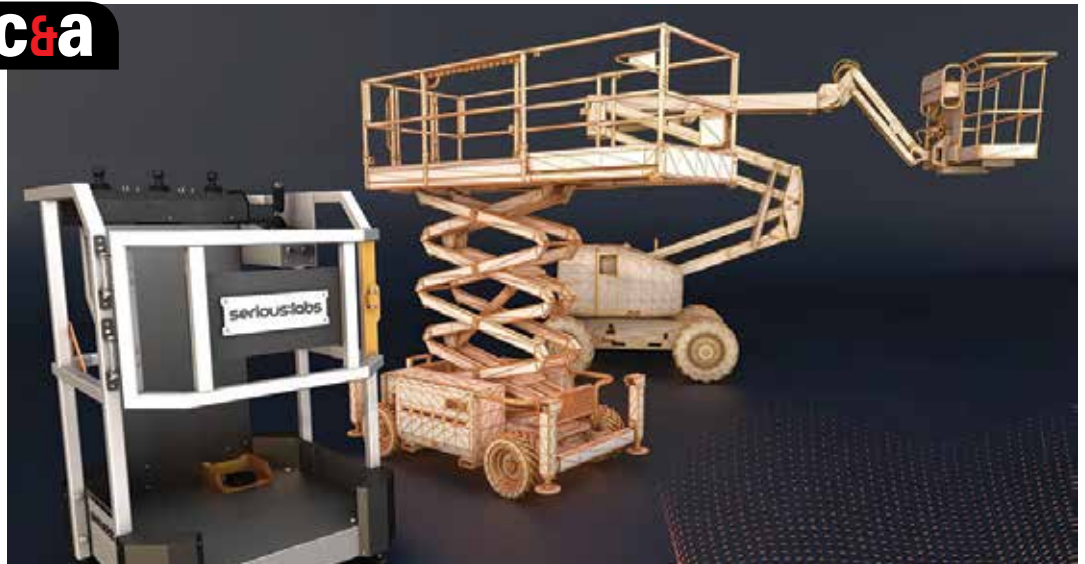
Serious Labs has developed airline modules for improved access platform training when working on aeroplanes

of thousands. The air simulation module allows operators to practice in a safe environment learning how to navigate their way around planes without making dangerous or expensive mistakes."

Although the aviation industry is struggling from the impact of Covid-19, Serious Labs is expecting a significant uptake for the software with Singapore Airlines placing the first order and air forces in both the USA and the UK also registering an interest.

Serious Labs has also concentrated its efforts on the way its simulators assess and score each operator's performance and - according to the company - its latest software update is now able to imitate the scoring criteria of a real life instructor evaluating the assessment with various examples

- including whether the operator has missed a visual inspection, used the incorrect control movement, and the way they have feathered the joysticks.

Verschuren adds: "Having 25 years' experience as a trainer, the exciting part for me is how we can use the data and scoring from the operators' assessments. For the first time, assessment data is 100 percent comparable, as it is always with the same conditions, time of day, type of machine and task to complete. This measurement will allow companies to manage their operators using a data driven approach as they currently do with other areas of safety. Hopefully in the not too distant future organisations will consistently monitor the safety and efficiency of their operators throughout the life

of their training qualification and not rely solely on a test every five years."

The company is also working on updates that will include a site inspection and risk assessment, as well as checking for machine suitability, visual inspection and function check from the ground and in the platform. In addition it is also looking to review ways to make the technology more accessible via a number of leasing and renting solutions.

VR enough to certify?

In 2018, the International Powered Access Federation (IPAF) welcomed and endorsed the use of VR technology for use alongside its theory and practical training programmes. It has since been working with Serious Labs to determine whether VR might be used to deliver its PAL+ advanced operator course and for the practical assessment for operators renewing their PAL cards, based on the fact that operators have already been assessed and certified to operate the real thing during their initial training. The results from the trails were expected to be announced in the coming months however the outbreak of Covid-19 will have delayed this until next year.

Serious Labs realistic work platform simulator with boom and scissor lift controls.

Serious Labs worked with Nationwide Platforms and Skyjack to develop scissor lift modules
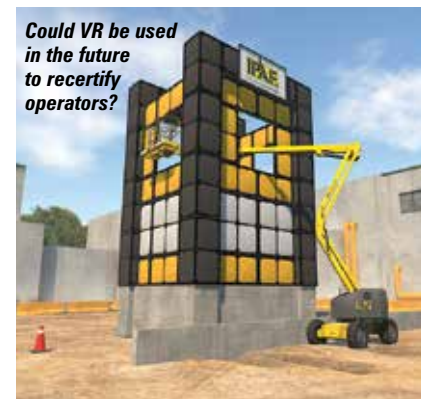
Could VR be used in the future to recertify operators?

In the NCCCO Foundation study operators carried out the same scenarios on the same crane models both in real life and in virtual reality

Virtual cranes

On the crane side, Serious Labs partnered with training provider Industrial Training International (ITI) to develop ITI's VR Crane Simulator. Launched in 2017, it originally offered virtual training on a 90 tonne Tadano GR-1000XL Rough Terrain crane and a 100 tonne Link-Belt 218 HSL crawler crane.

Christina Lanham, managing director of ITI UK said: "When it was shown at Conexpo 2017 it was received with excitement and scepticism. Could VR truly provide a high quality experience to train crane operators? Fast forward three years and it is

clear the answer is yes. The best thing that simulation offers is a safe environment to learn and to fail. Students can build fundamental skills that allow them to adapt and familiarise themselves with actual equipment more quickly."

The company has now expanded its offering to provide hundreds of training scenarios on seven crane models which include a Liebherr 550-EC-H tower crane, a Broderson RT 400 and IC 80 pick & carry crane, a Terex BT-28106 truck crane and a number of overhead gantry cranes. It is also working on adding a 300 tonne Liebherr LR1300 crawler crane module later this year.

Available on a full-motion platform or on a desktop simulator station - both of which feature a range of controller options which replicate the position, layout and operation of each crane - the software has recently been designed to help operators prepare for NCCCO practical examinations and general screening and qualification assessment.

Lanham adds: "Results from across a multitude of industries have shown that VR simulation trains people faster and they have a higher rate of retention. A company would rather have someone learn that being too heavy handed on the controls can cause shock loading in a simulation rather than on their actual crane where the damage can be costly."

VR able to predict pass rates?

Last year ITI's VR crane simulator was used in a study commissioned by the NCCCO Foundation to compare the outcome of operators performing the practical exam on a simulator with a real crane. Conducted over an eight month period, the study tracked the performance of 40 NCCCO candidates with a range of different experience levels, taking crane

operator certification exams on both the real cranes and on the exact same virtual crane using ITI's desktop simulator.

The results revealed the likelihood of a candidate passing the VR test but failing the test on an actual crane was just 5.6 percent. Whilst encouraging, the study concluded further research was required and that it was impossible to determine conclusively whether it would be appropriate to certify a candidate using VR technology. There was also one example in which a candidate - who had zero hours documented crane experience - scored a 98 on the VR test and 46 on the actual crane test potentially suggesting that the VR might be better suited for experienced operators.

ITI's Lanham commented: "The results showed a very high correlation between the testing methods. While we may not be able to certify someone on a simulator today, it shows that it is something that could be possible for the future. Simulation training is not meant to cover 100 percent of the training. At some point students need to touch the real thing."

ITI has worked with Serious Labs to develop modules for seven types and models of cranes

ITI's Crane Simulator can be used to prepare for NCCCO's practical examinations and general screening and qualification assessment

Better to make mistakes in a virtual world than the real world

CM Labs

Another pioneer and key player also from Canada is CM Labs Simulations which provides simulator training for a range of lifting, earthmoving, port and marine equipment. Its simulators range from its Vortex Edge Plus desktop simulator to entry level motion simulator Vortex Edge Max and finally its fully immersion simulator Vortex Advantage.

Launched earlier this year, Vortex Edge Max aims to provide an affordable option for high quality, fully immersive simulation-based training for mass market. Available with the full suite of crane and earthmoving modules, the motion base and replica controls - coupled with a large monitor - help simulate the motion and feel of real equipment.

Drew Carruthers director of product strategy says: "The construction industry is working to resolve a skills gap, but not every organisation always has the time, manpower or equipment available. Research shows that the shortage is intensifying, that's why we wanted to put a tool for bridging the gap into the hands of more people."

Each training module includes user friendly learning exercises which allow delegates to train at their own pace when training staff are not available. The simulator can also be paired with the company's optional Instructor Operating Station allowing trainers to make changes to training scenarios midway through a simulation such as the time of day and weather conditions as well as introducing unexpected occurrences, such as snag loads and mechanical failures.

The simulators are also able to connect to other simulators for collaborative group training, which includes the ability to carry out tandem lift training. Lead crane operators can be taught to safely and efficiently move a steel pipe load on a simulated job site with buildings and power lines etc. in tandem with a secondary crane operator on a second simulator. It can also be run in conjunction with the company's virtual signaller training course, which allows the trainee to guide the operation via a webcam and picture-in-picture display.

The company's new mobile crane training pack allows trainers to review operator competency with a crane skills assessment exercise which includes advanced lifting techniques, such as performing a blind lift, recovering load swings and girder lifts. The training pack measures up to 50 customisable machine, efficiency and safety metrics in real time, as well as factor in real life risks such as overhead power lines, buildings and people on site.

Carrying out tandem lift training is possible
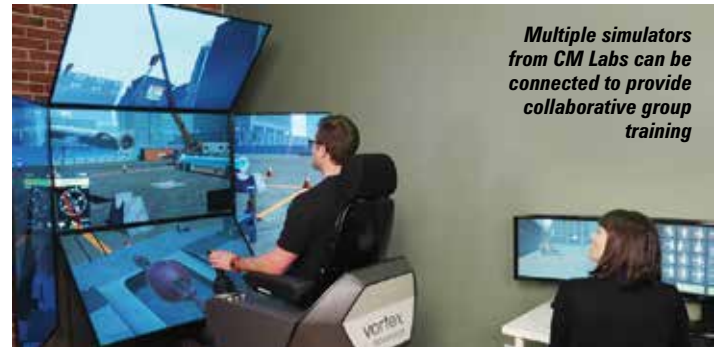
Multiple simulators from CM Labs can be connected to provide collaborative group training

CM Labs' new entry-level Vortex Edge Max will look to provide an affordable option for high quality simulations
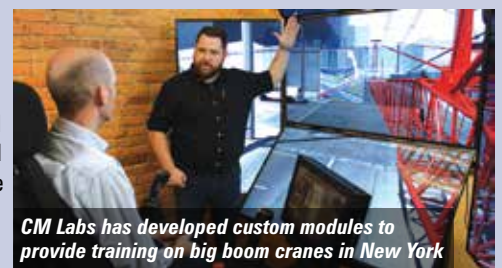
Big boom training

As well as working with several training providers such as Crane Industry Services (CIS) in the US and CITB in the UK, CM Labs provides custom solutions for a number of industries and applications. A recent example was for a bespoke simulation for the International Union of Operating Engineers (IUOE) after New York imposed strict licensing requirements requiring crane operators to have specialist training on erecting, rigging and operating cranes with boom lengths of more than 90 metres. Given the time, cost and safety considerations of training operators on large cranes within North America's most densely populated city is not always practical or even an option, a solution was required.

IUOE training director, Tom Gordon said: "OSHA has very stringent safety guidelines and New York City has requirements that exceed those. You can imagine how stressful and difficult it would be to make that your first time in the seat. Experiencing the controls, forces, inertia, twisting and movement of a crane, are critical to understanding the reaction differences between a 200 and a 300ft boom. Our top priority was to provide operators with detailed training for the procedures of erection and lay down such booms or luffing jibs. These are dangerous steps in crane operation and we had to get it right."

IUOE's requirements were so specific that Gordon was sceptical that a simulator could realistically reproduce the level of detail required to imitate the angles, point of

CM Labs has developed custom modules to provide training on big boom cranes in New York

jack-knife, controls, vision, rigging, loads, cables. In order to achieve this CM Labs's Carruthers explains: "We modelled the crane's inner workings exactly - every segment, every wire, every component. We had to identify what could behave how, and why, and then model those consequences exactly. Our simulations had to allow the equipment to be pushed to its limits safely without exceeding the tipping point."

IUOE is now able to train its operators on a range of advanced crane configurations in a safe and controlled environment. "It was truly a game changer," adds Gordon. "Our people spend days on the simulator and not just new operators. We are now able to provide advanced training for our journeyman and licensed operators who have been running cranes for years. We can also use it for licensed operators who perhaps haven't operated cranes in specific configurations and want to get comfortable with how it reacts."

Tenstar recently added VR headsets to its tower and loader crane simulators

Build it and they will come - a tool for attracting new blood?

Tenstar updated training solutions

Tenstar Simulation covers the transportation, construction, agriculture, forestry and automotive markets, including tower crane, loader crane and telehandler simulations. While it has historically used a motion platform system with joystick and monitors for its simulators, more recently its tower and loader crane courses have been updated to include a VR headset. These include either the standard Oculus Rift S headsets or the new Varjo XR1 and VR2 headset which use eye and hand tracking technology to better monitor student behaviour.

Modern features of the simulators include a 'Record & Replay' function, which can be used to analyse and evaluate past scenarios, and an improved Tenstar Scoring System which provides more detail on quality, safety and economy of operation. It has also introduced a new VR Walkaround module which allows users to move around and interact with a machine to learn about features and safety procedures, or conduct an inspection, opening hatches and climb on to the machines and get to know them.

Simon Hogg of Tenstar Simulation said: "The ability to use simulation to pre-screen an operator's current skill levels, combined with detailed analytical reports, allows the instructor to devise an effective tailor-made training schedule for the individual. We expect to see the use of this training technology increase even more in the future, with an array of virtual reality technology."

Real life benefits

The application, capability and adoption of VR within the lifting industry has gained serious momentum over the past few years and it would be hard to argue against the benefits. However, the question of whether VR will ever be able to offer anything other than enhanced training remains.

One company offering a glimpse of the future is Hiab with its HiVision VR system. Unveiled in 2016, it allows forestry workers to operate a loader crane from the safety and comfort of their cab through the use of VR. This is achieved by the installation of four cameras on the crane which provide 270 degree visibility through a virtual reality headset. Although currently limited in its application, it is not inconceivable that similar systems could be utilised for other applications.

The future of VR

To many VR might still seem a bit of a gimmick but any tool

Hiabs HiVis system allows lorry loader operators to lift loads from the comfort and safety of the cab

that increases operator training, operations or safety should be encouraged. Safety and training aside, the industry is also reaching crisis point with skill shortages as it loses out to more exciting, progressive industries. So perhaps a change in approach is required with VR providing much needed help. Drop a VR simulator into a trade or careers fair and watch them flock to it. And not just because it resembles a computer game - well that accounts for a lot of it - but it is also what most young people relate to and in most cases how they expect to learn and engage. If the use of this 'gimmick' can bring young people into the industry, then surely this can only be a good thing?

Tenstar's VR Walkaround module allows users to move around and interact with a machine

The training classroom of the future?