Igloo system heats up training

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During 2015, in collaboration with our project partners, BP undertook a proof of concept project to build an innovative, full-size, photo-realistic, interactive, and immersive 3D plant simulator, with the aim to enhance the skills, capability and confidence of our operating teams. This virtual plant connects to the existing Distributed Control System (DCS) control room simulator, delivering a realistic, safe environment, and allowing the control room operator and field operators to train together where their actions are bi-directional.

The BP European Acetyls Hull Site Operator Training Simulation suite is a leading exponent within the BP group, with over 25 years continued investment. This enables us to build and maintain a comprehensive library of high-fidelity, fully-dynamic simulation models of existing plants at Hull.

Its primary use is for the training and competence assessment of the Operations Department's control room operators, but is also used as an engineering tool to perform layer of protection analysis (LOPA) studies, engineering studies, testing new plant modifications and recently, also as a test bed and training tool for our DCS migration project.

Over the last 20 years, using simulation to train control room operators has become the industry norm, but the missing piece for us was about looking at how we could offer our field operators training opportunities in a similar safe and accurate environment, ideally in conjunction with the control room operator.

Previously, the technology did not exist to provide a realistic plant experience for field operator training. Investigations by members of our Operations team saw early versions of generic 3D simulator technology emerging, but this market was in its infancy, commercially unproven and initial trials were effectively cost prohibitive. We therefore had to look at the problem and combine innovative technology and solutions to solve the problem.

BP, via its Digital Innovation Organisation, had some experience in 3D modelling and simulation, and a desire to take 3D models into the training and simulation environment.

Previously BP has built 3D training systems via a screen and keyboard with some success. But for the training of plant personnel, we wanted a 'real' virtual environment: a virtual, fully-immersive 3D experience where the trainee can get a 'plant' experience in a safe and realistic environment. The Hull challenge boiled down to the following questions:-

• Could we develop a model of a brownfield site of an existing asset that accurately reflected and provided a realistic environment which was fit for purpose, including background sound and imagery?

• How could we provide a truly immersive environment to display the realistic and accurate 3D plant model?

• Could we link this new 3D model to the existing "traditional" control room simulator where the actions and effects are bi-directional?

• Could we articulate the assets in the 3D model, i.e. valves and gauges to work as in the real plant?

• How would we interface the model to the DCS simulator and control aspects of the 3D model – i.e. fire, sound, environment, night?

1. BP European Acetyls Hull Site Distributed Control System (DCS) Simulation suite

The BP European Acetyls Hull Site DCS Operator Training Simulation Suite has been a leading exponent within the BP group for many years for the training and competence assessment of Operations Department control room operators. Over the last 20 years, control room operators simulation has become widely used in industry. The challenge is around training field operators and working out how we provide similar functionality, which already exists for their control room counterparts.

This project aims to fill that gap and show that we can deliver a realistic training experience for them in a safe, simulated environment, as well as show the possibility to create other such models that are maintainable, cost effective and a transferable technology that we can assign to other BP assets worldwide.

BP, in collaboration with its project partners, has undertaken a proof of concept project to build an innovative, full-size, photo-realistic, interactive, and immersive 3D plant simulator with the aim to enhance the skills, capability and confidence of our operating teams. The virtual plant connects to the existing Distributed Control System (DCS) control room simulator, delivering a realistic, safe environment, allowing the control room operator and field operators to train together, where their actions are bi-directional.

Although we see this as primarily a training tool, it can potentially provide a multitude of technical uses, such as in Hazop studies, Incident Management Team activities and plant familiarization.

The control room simulator is now considered the industry norm; our aim is to demonstrate this can also be said for the field.

2. The next challenge – 3D virtual reality plant simulator

In Hull, the DCS simulator is established, but the missing piece was about how we could train the field operators in a similar safe and accurate environment, ideally in conjunction with the control room operator.

However, previously, the technology simply did not exist to provide a realistic plant experience for field operator training. The field operators have therefore been the 'poor relations' in terms of competency training and assessment.

Initial investigations by members of our Operations team saw early versions of generic 3D simulator technology emerging. However, this market was in its infancy, commercially unproven and initial trials were effectively cost prohibitive. We therefore had the chance to look at the problem afresh and combine some innovative technology and solutions to solve the problem.

BP, via its Digital Innovation Organization, has some experience in 3D modelling and simulation and the Hull challenge boiled down to the following questions:-

• Could we develop a model of a brownfield site of an existing asset that accurately reflected and provided a realistic environment which was fit for purpose, including background sound and imagery?

• How could we provide a truly immersive environment to display the realistic and accurate 3D plant model?

• Could we link this new 3D model to the existing "traditional" control room simulator where the actions and effects are bi-directional?

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But overall, could we deliver this realistic plant simulator to Hull in a cost effect manner that Hull could afford?

3. Why do we want to do this?

At BP European Acetyls Hull Site our aim is to carry out safe, reliable and compliant operations, running fully integrated manufacturing assets on a continuous basis. To enable us to do that, there are a multitude of actions which have to be undertaken within process operations by the control room operator, in liaison with his/her field operator and instrument/electrical and maintenance technician colleagues. This done incorrectly could have possible safety, environmental and/or commercial implications.

More than 25 years' worth of historical data from our control room simulator proved to us that an immersive and realistic environment enables us to strengthen the capability of our control room operating teams, which ultimately leads towards increased safety performance, less impact on the environment, increased plant reliability, enhanced recovery from plant upsets/trips and improved operational problem solving capabilities.

Our team recognized some weaknesses in our current capability with regard to the training and competence assessment of our manufacturing field technicians. Therefore, we wanted to replicate the benefits derived from our control room operator simulator programme throughout the entire operating teams and demonstrate commitment to our people, while providing them with the best in class training facilities available.

The 3D Igloo experience provides an opportunity to significantly enhance the training and development of our field personnel. This forms part of an overall risk reduction strategy and builds the capability of our workforce. Whilst the concept of training and assessing the competence of field operators in the field is not new, there are no other known facilities linked to an existing plant simulator where it is possible to actively simulate potentially hazardous and safety critical activities without endangering the safety of personnel or plant (or impacting on production).

Being able to train both individuals and teams in an immersive and realistic environment allows us to strengthen the capability of our operating teams, which will ultimately result fully across the board in increased safety performance, less impact on the environment, increased plant reliability, enhanced recovery from plant upsets/trips and improved operational problem solving capabilities. These benefits are transferrable and could be realized on any of the numerous assets across the BP group worldwide.

4. How do we do it?

For some time we have had the desire to take 3D models into the training and simulation space and BP has built 3D training systems via a screen and keyboard with some success. But for training of plant personnel, we wanted a 'real' virtual environment. A virtual fully immersive 3D experience where the trainee could get a 'plant' experience in a safe and realistic environment.

The team at Hull had the courage and ambition to explore how to develop this idea further to firstly suit the needs for ourselves, and then explore how to make this solution transferable across the entire BP group and beyond.

The solution would need to compromise of the following:-

Building the 3D model

A method to create an accurate, realistic and workable 3D computer model similar to a CAD model which would be available for a new plant of the existing and ageing plant.We initially used photogrammetry (mathematical software which uses pictures to build a 3D model of the content) utilizing specialist vendors. This basic model was then enhanced by graphic designers at Igloo Vision with skyline panoramic images to create the full size, realistic representation of the real Hull plant indoors.

Interface between DCS Simulator and 3D Model

A link from the 3D Model to the existing DCS control simulator via a games engine which could control the model.

For this, we commissioned a computer science specialist to write the software interface between the 3D model and the DCS simulator. The 'bridge' works both ways and valve positions and actions are delivered to the DCS simulator and the simulator gauge readings and valve positions are fed back to the 3D model.

Creating a 3D Immersive Experience

Provide the 'immersive' experience. The trainee would need to physically walk inside the model.

We used the 360 degree projection environment from Igloo Vision, which surrounds the trainee operator with a full size representation of the plant, complete with sound effects.

Combining these to create a total solution

Our aim was to seek for a total solution that could be utilised across the whole BP group, including on-going maintenance delivered at an affordable cost to all.

For the first time, this solution enables us to recreate a simulated plant with the ability to train and/or assess the control room and field operators simultaneously. The user navigates around the model and operates valves within the simulated plant world with a hand controller.

This project has demonstrated that the solution works. We are now looking to build a partnership to build models and further refine our solutions at an affordable cost.

5. What are the benefits derived?

BP European Acetyls Hull site has a history of pioneering the development of simulation systems, and in this field, has been a leading exponent within the group. Over 25 years, continued investment has enabled the site to build and maintain a comprehensive library of high fidelity, fully dynamic simulation models of the existing plant at Hull which are regularly showcased to a wide variety of internal and external clients. This investment has allowed us to foster learning and continually develop the capability of our control room operators, enhancing their knowledge and skills.

We see this innovative 3D technology forming part of an overall strategy to manage risk reduction, as we will be able to train and assess field operators in a much more realistic and immersive environment, either individually or in conjunction with the control room operator. Applying this novel technology to remote sites or installations would also enable teams to rehearse tasks prior to arrival at locations and minimize the time taken to carry out activities, as they would already be familiar with the geography of the site.

The 3D Igloo experience provides an opportunity to significantly enhance the training and development of our field personnel. This forms part of our overall risk reduction strategy and builds the capability of our workforce. Whilst the concept of training and assessing the competence of field operators in the field is not new, there are no other known facilities linked to an existing plant simulator where it is possible to actively simulate potentially hazardous and safety critical activities without endangering the safety of personnel or plant, or impacting on production**.**

The system has the potential to provide field operators, maintenance technicians and engineers with a safe and immersive environment additionally to:-

• Rehearse safety critical tasks

• Develop underpinning knowledge and develop 'muscle memory' reactions to adverse conditions

• Gain knowledge of plant geography without entering the plant

• Practice radio communications to be precise and confident

• Practice using mobile applications – e.g. procedures, plant checks and work order maintenance

• Maintenance Turnaround (TAR) planning and scenario practice

• Aid Incident Management Team support activities

• Support Hazop team activities

• Provide field technician continuous improvement and development opportunities

All these demonstrate our commitment to our people to provide them with the best in class training facilities available.

6. Continuous development programme

We proved the technology and application in the initial proof of concept project and learned a lot from the process. Throughout 2016/17 we have been using these experiences to develop this concept further, by exploring how to further reduce costs and accelerate the conversion process from initial plant scanning to complete model creation. As technology has developed, we have moved away from using photogrammetry and recently used laser scanning to model a much larger section of our asset which was used during our initial "proof of concept" programme. This Light Detection and Ranging (LIDAR) method also gives us higher definition images, with greater accuracy further increasing the realism and thus improving the operator's overall experience in the 3D world.

In our latest model, the asset area size has also been increased from one floor to all five floors of the previously modelled structure of our Syngas (Carbon monoxide/Hydrogen) production plant. This has increased the number of items scoped by a factor of 10, to around 120 items that reside in the DCS simulator. This gives us increased functionality for bi-directional training and competence assessments with the control room operator and field technician. Additionally, many other plant items not connected to the DCS can also be manipulated in the 3D world model to give the impression they are operable.

Model functionality enhancements and refinements have improved the operator experience and give us the ability to ascend and descend the various staircases and vertical ladders of the five floor structure.

Fire alarms check points are now configured for the technician to sound the fire alarm should they observe a fire or flame in the area which we have the functionality to simulate.

Now that our latest development work stage is almost complete, we aim to be undertaking practical training with shift teams working together for the first time.

The significant challenge we faced was around training field operators and working out how we provide similar functionality, which already exists for their control room counterparts. We believe our project fills this gap and shows we can deliver a realistic training experience for them in a safe, simulated environment. We also believe it shows the possibility to create other such models that are maintainable, cost effective and transferable so we can assign to other BP assets worldwide.

We are keen to promote our project and share our experiences and learnings. Our journey has already been showcased within our business and at a number of external events. We have also been the cover story article of a professional journal, The Chemical Engineer, issue 889/890 and received a "highly commended" status for the IchemE "Education and Training" and "Process Safety" Awards 2015, and finalists status for the IchemE "Education and Training" and "Process Safety" Awards 2017.

The control room simulator is now considered the industry norm. Our aim is to demonstrate this can be said for the field simulator, too.