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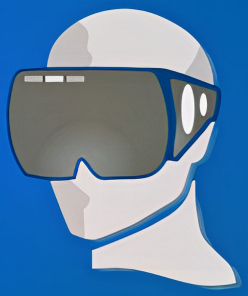

# SEA-VET.NET – GOOD PRACTICE

## Collaborative Virtual Reality (CVR) Simulation Training

*An immersive virtual simulation training approach for aircraft maintenance technicians*

May 2021

# Vocational Training in a Collaborative Virtual Environment

## Overview

| | |
|---|---|
| **Implementing Institution(s):** | Institute of Technical Education, Singapore |
| **Localities where practice has been implemented** | Singapore, Institute of Technical Education (ITE), College Central, School of Engineering (SoE) for the course: Nitec in Aerospace Technology |
| **Timeline/ Years:** | May 2018 - Present |
| **Target Group:** | Annually 6 classes (32 per class) of students from ITE College Central, School of Engineering taking the course of Nitec in Aerospace Technology |
| **Total cost incurred/resources required:** | Total Cost: $11040.90<br>Note:<br>1. 3 Gaming Notebooks<br>2. 3 Oculus Rift Set (w/Gear +sensors+ touch controllers)<br>3. 3 Network Switch<br>4. Cabinet ,Extension Cables, Batteries , Battery charger<br>5. Software: Unity 5.0 game building Engine<br>6. Software: Oculus Rift |

## CONTEXT

On-the-job training (OJT) is common in the aviation industry. More than 90% of the critical skills of an aviation maintenance technician are acquired through on-the-job training (OJT) (Walter, 2000). OJT's hands-on approach enables the learner to obtain knowledge through watching another perform the task; also to participate in accomplishing tasks under the direction of a qualified person until satisfactory demonstration of capability and competency.

However, some technical tasks are complex and hazardous; mistakes made during OJT could be disastrous and costly while affecting aircraft turnaround time. At the vocational institute, simulation of high-risk events such as engine fire or fuel leakage and leaving engines running during training, is not possible. Studies show that traditional approaches of classroom and OJT training may not fulfil the training requirements to meet future trends in aviation maintenance" (Haritos and Macchiarella, 2005).

On the other hand, virtual reality (VR) being computer-generated environments that simulate the physical presence of people and objects to generate realistic sensory experiences, has been applied to task training in many domains such as medical and military. It is often used in vocational training for areas in which the real situation may not be employed for practice due to lack of access to it or because it is risky, dangerous or expensive.

## IMPLEMENTATION OF THE PRACTICE

### *Collaborative Virtual Reality (CVR) Simulation Training*

In Singapore, the School of Engineering at Institute of Technical Education (ITE) College Central faced the challenge to provide a safe, productive and effective training for large aerospace technology classes using a single aircraft.

A project team comprising lecturers from the School of Engineering (Aerospace Technology) and the School of Electronics & Info-Comm Technology (Games Design and Development) in the Institute of Technical Education (ITE) held initial discussions on the possibility of creating a virtual environment where Aerospace Technology students can practice the engine ground run procedure safely.

Subsequently, the CVR simulation training was developed using gaming laptops, virtual reality tools such as Oculus Rift and Oculus Touch Controllers. The CVR simulation training was aimed to provide real-life safe training in aircraft engine start or shutdown procedures, simulating possible emergency scenarios that could happen during an engine run; such as engine fuel leaks or engine fires.

***The Innovation***

The CVR simulation training is an innovative solution in aerospace training to the available VR packages adopted by local higher learning institutions which were in single player modes.

In CVR aerospace simulation training, three students are now able to learn, discuss and perform the aircraft maintenance tasks in co-operation. Additionally, each group of trios are able to rotate roles and master skills via tutorial and simulation mode.

Students are kept on-task even while waiting for their turn whether in studying their job sheet or observing their peers in CVR simulation training. Figure 1 shows how the AET CVR is set up for 3 students playing different roles.

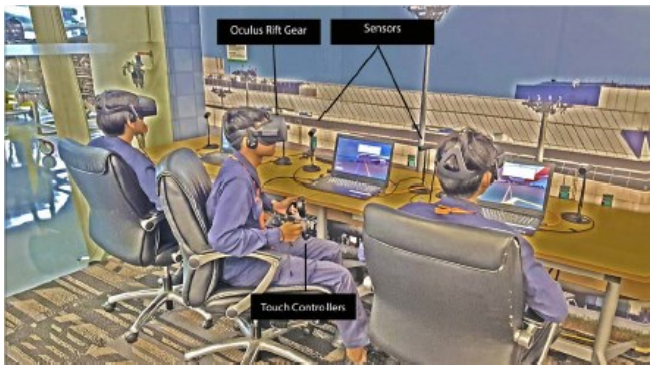


*Figure 1: An example of the AET CVR setup with 3 players*

***CVR Simulation Operational Set-up***

The CVR simulation training was developed with 2 modes: Tutorial mode to train users on performing the operations with step-by-step procedural guidance, and Simulation mode to test users' knowledge with a time limit and feedback mechanism.

In this CVR simulation training, three students will be tasked to carry out the aircraft ground run procedures in a virtual airport environment. The layout of the collaborative virtual environment is shown in Figure 2.

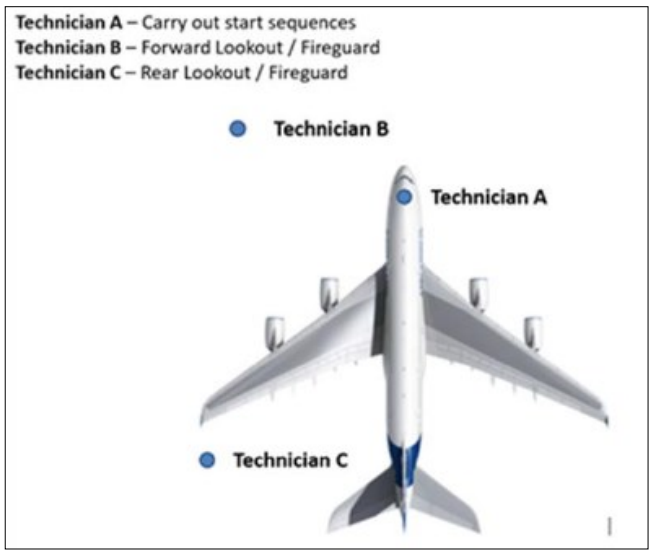


*Figure 2: Layout of the Collaborative Virtual Environment*

Students select between two versions of simulation types at the start screen:

1. **Guided Mode (Self-directed learning)**

   Students will receive step-by-step instructions to start up/shut down the A380. Some areas of concern are also highlighted (e.g. having foreign objects on the tarmac and area clear checks). Additionally, the step-by-step firefighting or the fuel leakage procedures will be shown.

2. **Unguided Mode (Assessment of competency)**

   Students will not be given instructions to perform tasks. However, students will be prompted if errors are committed. They must also communicate effectively to get the job done. A Scoreboard (or performance log) will be an added feature in the learning package for learning evaluation purposes.

## IMPACT OF THE IMPLEMENTATION

Student feedback gathered from online survey questionnaires and focus group discussions after completion of the CVR simulation training package shows high perceived levels of learning effectiveness; in terms of increase in interest, gaining good understanding of the topic and finding the learning activities meaningful. The students were satisfied with the knowledge gained via more independent and flexible learning methods, and most of all the gamified learning experience.

Following are the beneficial impacts from CVR simulation training:

a. **Enhanced spatial knowledge representation**

   Students performed learning tasks in the cockpit and hangar in the CVR simulation training. These are places usually not accessible to students. In the VR environment, students felt that they were able to "really see" and develop familiarity with these places. They were also able to have first-hand experience interacting with objects exhibiting dynamic behaviour, e.g. "try to on switches to see what happens".

b. **Facilitate experiential task**

   Students valued the opportunity to experience and practice on scenarios that were not possible in real life, e.g. fight a fire. They perceived that the experience prepared them to handle similar situation when they go to work, having already experienced it first-hand in the CVR simulation training, which was less stressful and risk-free.

c. **Engagement**

   Students felt more engaged while performing hands-on tasks in the CVR simulation training as compared to listening in class. They were more motivated to learn through the CVR which was "more visual and practical" and "like a game" as compared to learning from books which were "harder to understand". They feel that "fun is when the most learning takes place".

d. **Contextualized learning**

   Students found that the CVR simulation training helped them contextualize what they have learnt in the school to a real work situation. They perceived a greater

retention of knowledge and felt that they can transfer the learning to future workplace.

e. **Collaborative learning**

Students found that interdependent tasks performed in the CVR simulation training enhanced collaborative learning beyond what is possible in school. The collaborative learning was effective and improved their procedural knowledge on the task performed by different roles. They also felt that the collaborative skills that they built while working with friends can prepare them for collaboration in the workplace.

## REPLICABILITY

The Aerospace CVR simulation training could potentially be used by other higher learning institutions teaching aircraft maintenance related course, aircraft SAR-147 approved maintenance training organisations, the Republic of Singapore Air Force or MRO (Maintenance, Repair and Overhaul) companies in the aerospace industry.

In ITE, the School of Engineering is mulling cooperation with School of Electronics and Infocomm Technology to adapt the simulation training curriculum package to other aircraft trade areas such as aircraft marshalling and aircraft hot brakes check.

Here are the key milestones that ensured successful implementation of the project within 12 months, which could be referenced for replication of CVR simulation training (See Figure 3):

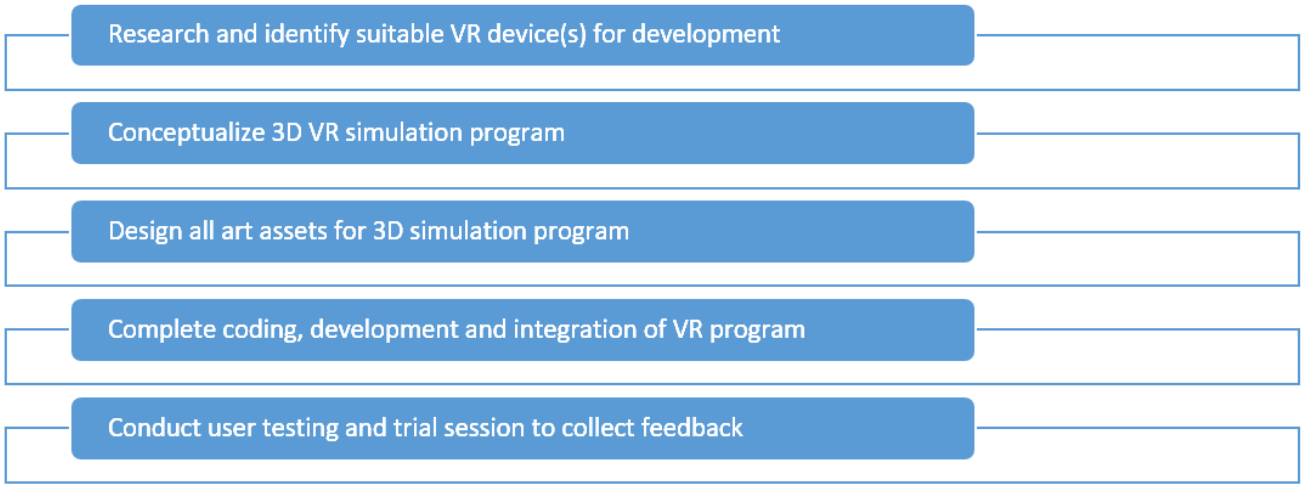


*Figure 3: Key Milestones*

| *Task No.* | Project Tasks | Timeline | Person-in-Charge |
|---|---|---|---|
| *1* | Research and compare VR hardware. Recommend VR devices most suitable for the CVR game play and interaction. | July – Sept (2 months) | GDD CM/SH, GDD LT |
| *2* | Generation of Storyboard for VR game flow based on actual procedures for Engine ground run and current practices. | July – Sept (2 months) | AET SH, AET LT |
| *3* | Design VR game flow based on actual procedures for Engine ground run and current practices as advised by Aerospace Staff. | July – Nov (4 months) | GDD CM/SH, GDD LT |
| *4* | Create game assets, including 3D modelling and animation of all assets to be used in the game. | July – Dec (5 months) | GDD LT, AET SH, AET LT |
| *5* | Design game User Interface and User Experience to make the 3D simulation more intuitive and authentic. | July – Dec (5 months) | GDD LT |
| *6* | Procurement of hardware based on recommendation. | Dec – Feb (2 months) | AET SH, AET LT |
| *7* | Game programming and development. | Oct – Apr (6 months) | GDD LT |
| *8* | Game testing, trial and user data collection. | May – Jun (1 month) | AET SH, AET LT |
| *9* | Progress update and final report. | Jul – Jul (12 months) | GDD and AET CMs with inputs from all members |
| *10* | Demonstrate VR simulation game to visitors at Immersive Technology Centre to seek feedback and explore commercialization opportunities | May – Jul (2 months) | GDD and AET CMs |

CM – Course Manager SH – Section Head LT – Lecturer

*Figure 4: Summarized detailed tasks and activities undertaken by various stakeholders*

## LESSON LEARNT

In an effort to continually improve the learning experience with CVR simulation training, feedback from the instructors and students were considered. For example, size of text fonts that appeared in the VR program was increased as spectacles could not be worn together with the VR gear.

VR proficiency does not come automatically and students need to be taught how to interact in the VR environment using the controllers. Other than teachers as the guide, student helpers were engaged to assist first time users with the VR experience.

Guided by the Experiential Learning Approach (Kolb, 1984), lecturers critically evaluate the learning and develop more appropriate learning opportunities for students in terms of concrete experiences, reflective observations,

abstract conceptualization and active experimentation.

The lecturers learned to utilize data from the students' performance scoreboard log built into this CVR simulation training as feedback of individual students' learning performance. Learning gaps of specific students are addressed with lecturers reinforcing concepts, skills and knowledge as identified.

## CONCLUSION

The CVR simulation training provides an authentic, safe and immersive aircraft–working environment; which equips students for real job demands, without exposing them to the risks associated with hazardous training tasks such as the aircraft engine ground run process. The non-threatening and risk-free learning environment enables not-yet-skilled students to make mistakes for learning, without the risk of accidents or improper operations.

The pedagogical advantages of integrating collaborative learning while enabling self-directed learning through an engaging game-based methodology is a novel approach for the young generation. The extra flexibility of guided learning without the instructor encourages regular frequent training as-and-when needed.

Considering the overall cost reduction via CVR simulation training, such as savings related to cost of fuel, maintenance, crew costs and big central space, CVR simulation training has potential to sustain vocational training and learning in the aerospace industry.

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