Choices when adopting digital simulation in aviation

Potential Choices for Implementation in Society

Introduction

The use of digital simulation technology is emerging as a promising tool that could completely revolutionise both the aviation industry and society as a whole. Augmented – Reality (A.R.), Virtual – Reality (V.R.), and regular non–immersive Flight simulations are some of the possible ways our society can choose to adopt these tools. Each of these choices offers its own set of advantages and drawbacks. Considering these key factors, we can evaluate how the implementation of these tools can drastically impact our society.

A.R. simulators

Augmented – Reality Digital Simulations have become integral in the aviation industry, providing a safe and cost–effective means of training for future pilots. What sets A.R. technology apart from other forms of digital simulations is its use of projecting computer-generated elements onto the real world. External elements to the aircraft are represented through an augmented reality device to the user. This is done through implementing features such as motion simulation to replicate the feeling of flying in an aircraft.

A.R. technology has shown potential in the use of flight training, both in ab initio ("From the beginning", building foundation skills) and higher piloting levels. A study by Moesl. B. et al. (2022) indicates that in some areas, the use of A.R. technology is more efficient than traditional training methods. A key factor to this is its high capabilities of immersion. Due to the multimodal interaction in A.R. activities, this motivated higher emotional engagement and increased user interest. In more immersive activities, students are more likely to connect with these emotions and be more performance driven.

An advertising quality of Digital simulations is the capabilities of simulating flight in a safe, controlled, and remote environment. This is a common benefit shared between both A.R and other simulative technologies such as V.R. A study by Moesl. B. et al.(2022) highlights the time and cost efficiency this technology offers as opposed to conventional real flight practice. Real flight practice can take upwards to several weeks and will require high long-term maintenance costs for the aircraft. Time restrictions will be alleviated as users have the freedom to easily access training through a singular device. In addition to this, it offers opportunities to further prepare and train students in various scenarios where actual training is not accessible.

V.R. simulators

Virtual – Reality (V.R.) simulation tools are another increasingly popular tool that has shown its efficacy in the aviation industry. Immersion is another aspect which V.R. technology excels in. It allows users to experience an environment that goes beyond the limits of the real world. The unique quality of V.R. technology is that it visualises a completely computer-generated environment. This is done entirely through a headset with a built-in display, equipped with specialised software and sensors to replicate 3D movement. This is prevalent in mimicking the visual experience of controlling an aircraft.

Aside from pilot training, recent studies on aircraft pilots show the use of V.R. technology in cognitive health screenings for older pilots. A study by Benthem. K, Herdman. C. (2021) highlights the capabilities of V.R. technology in measuring cognitive skills, situational awareness and prospective memory of users. As V.R. transmits them into a virtual world, it simulates realistic flight scenarios enabling for more accurate evaluations of pilots' cognitive abilities. In terms of safety and risk mitigation, V.R. technology can prove to be a useful tool in evaluating and identifying older at-risk pilots.

Furthermore, research indicates that V.R. technology can also be a potential alternative to traditional teaching methods. Confirmed in a study by Dymora. P. et al. (2021) the utilization of V.R. technology was able to output better results than traditional training methods. It showed an "increase of 21 to 32.7% correct answers" after training with a V.R. simulation. From these findings, we can evaluate how V.R. simulation can be a more effective way to educate students than existing options. Rather than depending on traditional lecture-based teaching and having to remember facts, simulation-based technology could assist in providing the same essential flight knowledge. V.R. technology can provide better visual representation to students and enhance better user engagement by simulating the sensation of actually being in an aircraft.

Non-Immersive Digital Simulators

Non-immersive digital simulators, unlike A.R. and V.R. technology, are visualised in 2D on a screen. This form of digital simulation has been in use for much longer. This simulation provides a virtual representation of an aircraft without completely immersing the user in a virtual environment. This type of simulation is presented completely on either a singular or multiple computer screens without the use of any sensory devices. Users instead interact using input devices such as a keyboard, mice or external controllers.

Moreover, an advantage that non-immersive digital simulators can provide to the aviation industry is its capabilities in digital twin technology. Digital simulations can also allow for system integration and testing of physical aircraft components by providing a virtual 'twin' which can be extensively assessed before its final implementation. This is highlighted in a study by Schleich, B., (2017) by reviewing the promise digital twin modelling has in production

engineering. It offers manufacturers a way to properly review and analyse a virtual mock-up, speeding up new product development. Companies such as Airbus and Boeing are already in the works of developing digital twin aircrafts and engines as per a study by Xiong, M., (2022) which can be evidence of its high promise in the industry.

In terms of flight training, despite its lack of immersion technology, regular flight simulation technology also shows itself to be an effective and more widely accessible alternative to conventional flight training. Regular flight simulation has, like its immersive counterparts, also shown to be effective as an alternative to real flight training. A case study by Saastamoinen, K., et al., (2021) tested a Grob G115E simulator (GO simulator) in Air Force elementary flight training. The feedback from the users responded that simulation training to be an "indispensable part of flight training" suggesting that the efficiency of non-immersive simulation training to also be a potential choice for adoption into flight training. However, non-immersion technology can be accessed completely though a computer without the requirement of extra A.R./V.R. equipment. There is a selection of flight simulation software available to the general public. In comparison to A.R./V.R. training, this type of simulation can be more widely accessed to train whenever users please, such as from home.

Challenges to be considered

On the contrary, there are still limitations to what A.R. technology can replicate from conventional flight training. A recent study by Ajorni. D. et al. (2023) evaluates the impact of how training under stress can improve performance during real flight scenarios. As opposed to simulation training, real flight training shows higher stress levels in comparison to simulation training. Because A.R. simulation takes place in a safe and remote environment, there is a misconception of danger and fear of failing, resulting in lower stress levels.

In addition to this, research points out the importance of identifying noticeable health issues in V.R. flight simulation. A study by Dymora. P. et al. (2021) recorded common physiological problems such as headaches, dizziness, or motion sickness which may come as a result from extended exposure to the V.R. simulation. These health concerns must be carefully considered when adopting this technology into the aviation industry. A potential workaround for this issue is to ensure that safety measures are implemented to mitigate these risks.

In terms of flight training and compared to A.R. and V.R. technology, regular flight simulators can be more costly when used in a higher-grade setting which is indicated in the study by Saastamoinen, K., et al., (2021). Replicating the environment of an aircraft cockpit can be quite demanding, especially in higher fidelity simulator models which require complex technology. As the regular flight simulations operate entirely through a monitor, the immersive capabilities will not be as effective as A.R. and V.R. technology. Because of this, more complex technology such

as motion simulators and a physical replica of an airplane cockpit was used to compensate for this. As a result, “the operating costs and acquisition prices of the simulators can also be considerably high”. Although regular flight simulators are more widely available in a casual setting, in order to be properly implemented as an effective interpretation of flight training, the high demands of the technology can be challenging.

Conclusion

Simulation technologies have become integral within the aviation industry. In particular, A.R., V.R. and Non-immersive digital simulation technology all show great promise in impacting our society. A.R. simulations’ multimodal properties prompt better emotional involvement from users and promote higher performances during training. In addition to this, V.R. simulation’s ability to immerse the user into a virtual world has allowed for better measurement of the user’s cognitive ability. In contrast, regular non-immersive digital simulations can be a more accessible alternative to their immersive counterparts. These potential implementation choices have all indicated potential alternatives as flight training tools. However, potential health risks need to be more carefully considered when implemented into our society to ensure that the well-being of users is prioritised. Overall, each option of simulation technology has their own challenges that need to be considered, however overall offer a different set of advantages that indicate a revolutionising impact on society.

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