# Virtual Reality as a Mission Familiarization System for Deployed Mobility Aircrew (DRAFT)

**By**

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**Virtual/Augmented Reality and Related Technologies**

**18 JAN 2018**

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**Abstract**

Based on observations in theater, a virtual reality (VR) system allowing a mobility aircrew the chance to practice an operation before the mission would improve crew efficiency and improve survivability. This paper examines the current literature and projects to assess if this is a project worth further study. While the current literature does not directly answer the question, studies in related areas as well as in constructivist learning theory indicate that a VR rehearsal system would improve learning and team collaboration, with potential gains in effectiveness. Because of this, the paper recommends a pilot program to confirm the projected benefits.

## Introduction

### - Research Question

Aircrew conducting operations in combat or other high threat areas are not able to familiarize themselves with the mission area through direct observation, both for safety and for operational security reasons. Will a virtual reality (VR) system allow the aircrew to "fly" a rehearsal safely and benefit enough from the rehearsal to justify the fielding of the virtual reality system?

### - Problem Background and Significance

The USAF is postured as an expeditionary force. Flying missions over known terrain is the exception, not the rule. Because of this, most airdrop missions will be on locations never experienced by the aircrew. To counter this, the Intelligence and Tactics sections brief crews on the location to prepare them as much as possible for the mission. However, these are poor substitutes for actual experience. Can VR provide an experience closer to an actual mission?

### - Methodology

The development of this paper depends heavily on scientific literature, along with examples from the current state of VR.

**Background**

In 2012, Air Force C-27s tactical airlifters and crews were deployed to Kandahar Air Base in Afghanistan. While deployed, airlift aircrew were tasked to conduct operations to drop supplies to troops operating in the field away from usable landing fields. Because of the mobile nature of the conflict, most drops would be to locations not familiar to the aircrew. This is even more true today.[1] Normally, both the intelligence and tactics sections briefed using annotated maps that included terrain features and threat information. However, because of squadron personnel taking advantage of available technology, some of the crews were briefed using the "video flight" feature of Google Earth, which allowed them to see what a flight along the ingress would look like. This style of briefing was very popular with the crews, allowing them to experience the approach to the drop closer to how they would see it during the mission. Based on this experience, it seems a virtual reality rehearsal would allow an even closer to an actual flight.

Using a VR system, you would be able to sit in the cockpit or look out the troop door or the open cargo ramp of a virtual airlifter and see the terrain below. Instead of Google Earth's point of view, that mimics a camera on the nose of the aircraft, the point of view of each of the crew would match a position on an actual mission, including potential blind spots and being able to look at the terrain ahead, below and behind the aircraft. Combined with the point of view changing as if you were in a moving aircraft, the rehearsal system would be an experience closer to what they would see on the mission (see Figure 1).

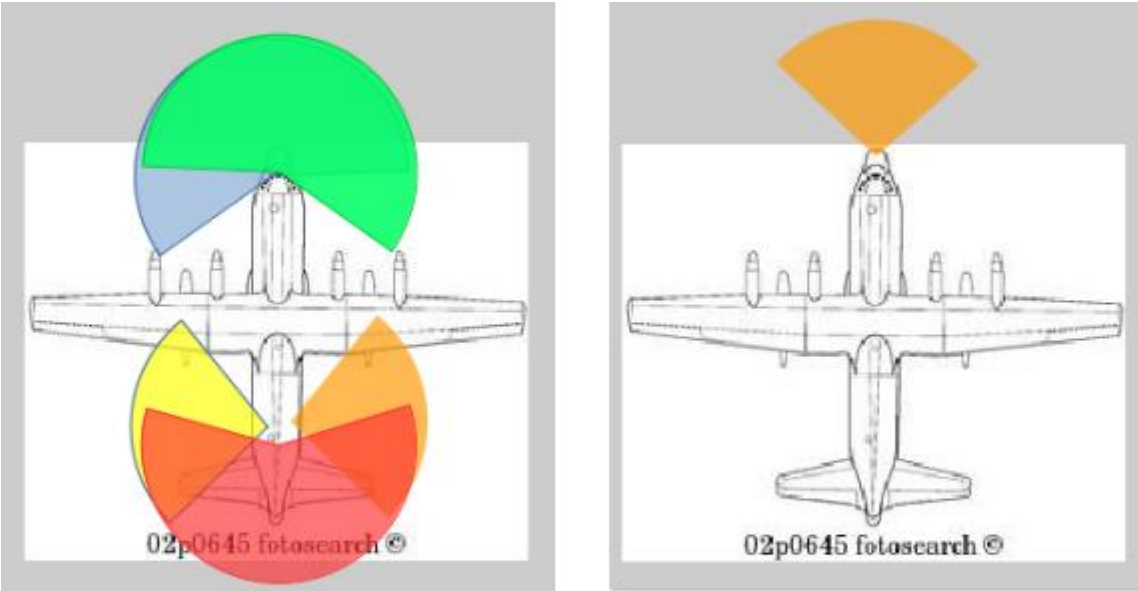


*Figure 1: A comparison of the views from the crew stations of a C-130 (L) vs. the point of view using Google Earth (R).*

One possible hardware configuration of the rehearsal system would consist of 5 VR "rigs" (a headset with headphones and microphone, along with hand controllers and a laptop computer) for the use of the four crew members and an "in VR" observer if needed or desired, plus an additional computer to handle inputting of information and generation of the simulation. Besides the mapping and other mission data, the additional computer would make sure all the crew an accurate view based on both their location in the aircraft and their head movements. All of this equipment would fit in one or two deployment ready cases, minimizing the unit's additional deployment footprint.

The creation of a virtual reality rehearsal system and subsequent purchase, fielding, training and supporting of the system would require both time and money. To justify the resources, there must be demonstrable benefits that such a system brings to operations, such as showing the benefits of virtual reality training to improve the knowledge and skills aircrew will use on the mission. This will require research into learning theory. Using those theories can show how VR makes learning more effective.

This will in turn drive the development of VR system capabilities to ensure that the system will provide those benefits to the aircrew.

Examining the literature, there is little material on a rehearsal system such as this. However, there are studies on medical rehearsal systems that improve operations and teamwork. There are also studies on how VR aids in learning. These studies talk about the importance of presence and the linking of physical and mental activity. Other studies discuss how making the VR more engaging improves the experience. This availability of related materials should mitigate the lack of direct studies, at least enough to justify further studies.

**Evaluation Research Criteria**

When evaluating the available literature I focused on recent scholarly work. The state of the art in any technology undergoes rapid change and this is even truer for VR. The older the reference, the more likely it will reference technology that has since been updated or even made obsolete.

Likewise, I have tried to use scientific journals when possible. I did this primarily because the work provides more support, but also because it is less susceptible to overstatement. The popular press often oversells emerging technologies, meaning it would be risky to use them as part of the foundation of the paper. However, due to the slower nature of scientific journals, much of the knowledge on VR is found in the popular press, so it cannot be totally ignored.

**Analysis of Research**

Analysis of the research centered on three important factors in the effectiveness of the VR system: constructivism, presence, and collaboration. These factors appeared when the unit in Afghanistan used the video feature of Google Earth to brief aircrew in Afghanistan. An important thing to remember is that they were not briefing new or original material by using video. Google Earth was the source of both versions of the briefing. The difference was not in the material presented, but in the presentation of the material. The point of view and the sequential presentation of the data allowed the aircrew to receive it in a way that was closer to the way they would experience it in real life. In addition, the continuing unfolding of the path into the drop zone provided a form of immersion, flying the approach as much as viewing it. Finally, the crew could talk to each other as they shared the experience, allowing them to collaborate on the learning, making the experience more than the four of them watching it separately. These three factors are what a truly effective rehearsal system should bring to the fight. Understanding how to employ these factors will provide the desired results of increased effectiveness and improved survivability.

Constructivism is an educational theory that believes learning comes from connecting what they are experiencing to what they already know or have experienced. This means that the person learns more effectively if the authors tailor the material to their current knowledge. In addition, the method of presenting knowledge is less teaching and more facilitating. Helping them to make the connections needed to incorporate the new information is as important as the information itself, because of the possibility of the information being lost without the connections. This also means that the method of presentation of the information is important: the easier it is to incorporate the new data into the existing knowledge, the more effective it will be. Experience, therefore, is better for learning than lecture, which brings us to presence.

Presence is in many ways the hallmark of VR. It immediately hooks the user, putting them into the created world. When used correctly, VR provides audio and visual inputs in a way that allows the viewer to experience a world just as if they were there, hence the term "presence."[2] Understanding what is and is not important to presence allows developers to focus on what they need to create a mission rehearsal that will engage the aircrew and help to optimize their retention of critical information in an operationally useful form.

The reality of flight in an Air Force aircraft is it is primarily a visual medium. Unlike a more natural environment, the flight and cargo decks of an aircraft in flight have background noise from the engines and other mechanical systems of the aircraft. Because of this, there will be little need for subtle audio cues to enhance presence. The background noise comes from every direction, while intercom and/or radio will come through headsets, so there is little need for the complex visual cueing needed to match sounds to locations in VR. Therefore, a lot of establishing presence within the VR mission rehearsal system will rest on the ability to display visual data in a way that simulates the reality of a mobility mission. It is important that the aircrew see the terrain as close to the way that they would see it on the flight to give them the best opportunity to create the desired learning connections between the presented mission data and the upcoming mission. Because airdrop missions often fly at night, the system will have to simulate the inputs given by night vision goggles (NVGs) that the crew wear for night missions. It may even be that the VR system will have to degrade the system's level of visual accuracy to match that of NVGs normally used on missions. Because of this, understanding the visual capabilities and limitations of all parts of the system, including the users, will be vital in order to meet the rehearsal system's goals.[3]

A better understanding of the system is another compelling argument for using the VR Rehearsal System at home station as well as deployed. Being able to demonstrate that the system was easy to use and provided a useful way of preparing for missions would increase learning motivation and encourage use of the system in theater much better than seeing it in theater without prior exposure. While this might increase costs and require modeling both training routes and drop zones, the increase in learning motivation would be worth it.[4]

Collaboration is very important for mobility missions. While other types of missions rely on communications between pilots who are each in charge of their own aircraft, mobility crews are doing separate tasks in the same aircraft. The pilot and copilot work in the cockpit, ensuring the aircraft flies over the target at the correct heading and altitude. On the cargo deck, the loadmasters work to make sure the cargo goes out of the aircraft at the correct time and properly configured for the drop. Making the rehearsal a team experience will improve team cohesion and will make the knowledge easier to gain and maintain. Colonel Cook of the RCAF pointed out, "Aircrew can use VR to mentally prepare and develop the muscle memory for the mission. This then reduces the cognitive load in mission freeing up resources to deal with the unexpected."[5]

Again, there is a lot of common ground between medical teams and aircrew. Both need specific skills and the ability to work together. The reinforcement of skills through the three stages of learning described in the journal Military Medicine (declarative, associative, and procedural) would be important for aircrew as well.[6]

The benefits of using VR/AR as an aid to mission rehearsal can best be described using the constructivist theory of learning, due to the goal of equipping the aircrew with more usable knowledge of their mission area. Because of this, making the learning more collaborative and re-imagining the instructor as facilitator are vital. To engage the aircrew, making the rehearsal more immersive and closer to the real thing should be a vast improvement over the traditional slide deck enabled lecture.[7]

**Section V: Recommendations**

- The Air Force should develop a prototype system for test use at an air mobility training facility, such as the Advanced Airlift Tactics Training Center.[8] The goal would be to test the system by using it with aircrew unfamiliar with the training drop zones. Having some aircrew use the VR system while others use conventional procedures would allow the Air Force to gauge the effectiveness of the system.
- Research into the usefulness of VR in mission rehearsal needs to include a way to measure its effectiveness. While the use of Google Earth generated videos used in Afghanistan to familiarize aircrew on airdrop approaches appealed to the aircrew, there was no way to measure if it had an effect

(positive or negative) on the mission. The Air Force will need a more accurate answer to justify the investment of time and funding in this system.[9]

- If the prototype shows promise, they should follow that with a formal proposal for a system for unit use. The proposal should be developed by laying out all the support and planning needed to implement a VR rehearsal system. Besides "buy in" from the aircrew, we need the active participation of the instructor aircrew in order to make this an integrated part of the unit's mission, rather than an isolated bit of "gee whiz" technology. Such a system will need to have a broader footprint across the training environment. Not only will it be more involved with the continuous training at the deployed and home station unit, but perhaps a part of either basic or airframe specific crew training as well.[10] In addition, a mission rehearsal system would need logistical and educational support to avoid becoming unused equipment during the deployment. Finally, becoming an established Air Force system would help protect the network bandwidth needed for use at home and in theater.[11] They will need answers to all of these issues in order to deploy a successful program.
- Any aircrew that might use the VR rehearsal system should start using it at home station. This would allow them to become comfortable with the system and confident enough with it Likewise, flight surgeons should familiarize themselves with the possible health effects of VR adaptation. While illnesses such as "VR sickness" are rare, any training that might have a physiological effect on aircrew deserves vetting, lest aircrew acceptance of the system suffer. In addition, any VR situation that would affect depth perception would have to be reconciled with the depth perception issues with the night vision goggles (NVGs). NVGs are standard wear among aircrew, and we would want to make sure during VR rehearsal the view through the NVG simulation of the VR would carry whatever distortions real NVG use has. It would be counterproductive for the VR to allow better visuals than actual NVGs.[12]

- The system should be designed to make it easy for the aircrew to use. One study shows user's attitudes towards VR learning systems to determine which factors have more of an effect on the user's learning outcomes.[13] Their results indicate that factors such as perceived usefulness, perceived self-efficacy, and ease of use can all contribute towards motivation to use the learning system.

**Conclusions**

A VR Rehearsal system could be a vital system for mobility missions. If even one aircrew avoids mishap or injury due to a VR rehearsal, it will have paid for itself many times over. While there are impediments to deploying such a system, such as expense, additional support and bandwidth, and additional pre-mission time, there are many benefits. Our Mobility Air Forces (MAF) are expected to operate anywhere in the world with little notice. The addition of a VR rehearsal system has the potential to not only increase the MAF's ability to fulfill these expectations, but to do it at lower risk than currently possible. The system's ability to allow aircrew to "fly" a mission without risk will give aircrew the experience that will help them in the real mission. The Air Force should develop and test a prototype system at the first opportunity.

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