

SAFETY AND QUALITY IN AVIATION TRAINING WITH VIRTUAL REALITY [BEZPIECZEŃSTWO I JAKOŚĆ PROWADZONYCH SZKOLEŃ Z WYKORZYSTANIEM WIRTUALNEJ RZECZYWISTOŚCI]

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ABSTRACT: Recently, virtual reality is a valuable tool for learning in the aviation area. There are still many problems that require further research, especially those related to the awareness of the possible benefits and risks of using new technologies. The basic question relates to the quality of training using virtual tools. The main research problem was included in the question: How can the use of VR in flight training increase the effectiveness of acquired training material. The purpose of this article is to determine whether the use of virtual reality tools is an effective and safe form of education at an aviation academy. To achieve the intended goal, an analysis of the materials available in scientific publications was conducted, as well as a survey of academy students and cadets on the use of VR during classes in the field of security on board aircraft against terrorist acts.

STRESZCZENIE: W ostatnim czasie wirtualna rzeczywistość (VR) jest cennym narzędziem do nauki w obszarze lotniczym. Nadal istnieje wiele problemów, które wymagają dalszych badań, szczególnie związanych ze świadomością możliwych korzyści oraz zagrożeń podczas użytkowania nowych technologii. Podstawowe pytanie, jakie przyświeca podjętym rozważaniom, odnosi się do jakości szkoleń z wykorzystaniem wirtualnych narzędzi. Główny problem badawczy został zawarty w pytaniu: W jaki sposób użycie VR w szkoleniach lotniczych może zwiększyć efektywność przyswajanego materiału szkoleniowego. Celem tego artykułu jest ustalenie czy korzystanie z narzędzi wirtualnej rzeczywistości jest skuteczną i bezpieczną formą edukacji w akademii lotniczej. Aby osiągnąć zamierzony cel, dokonano analizy materiałów dostępnych w publikacjach naukowych jak również, przeprowadzono ankietę wśród studentów i kadetów akademii na temat zastosowania VR podczas zajęć w zakresie ochrony pokładu samolotu przed aktami terrorystycznymi.

KEYWORDS: Studies, virtual reality, educational tools, method of teaching, safety, hazard.

SŁOWA KLUCZOWE: nauka, wirtualna rzeczywistość, narzędzia edukacyjne, techniki nauczania, bezpieczeństwo, zagrożenia.

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1. *Introduction*

Aviation leaders are looking for ways to have all the workers to be graduates in aviation area each year. The researchers are looking for possibilities of using an all-enveloping VR headset which create a faster, more effective way to train. Last 5 years with VR tool has proven it as a very good solution in education. Unfortunately, it is generally only kind of support of the traditional undergraduate or training program in aviation.

The Air Education and Training Command program integrates various technologies to train pilots and crew members in an accelerated, cost efficient and learning-focused training environment. Students will still do many of the things they did before but they will have new possibility for creation. For example, they'll still go training to emergency situation in real environment. The pilot cadets will still climb into a hyperbaric chamber so they can experience lack of oxygen in the bloodstream or hypoxia under control medical service.

The emerging technologies are being used to decrease the time and cost of training, without sacrificing depth of learning.

2. *What is virtual reality?*

Virtual Reality (VR) is a 3D image that was created by the computer. VR can depicts different objects and even entire occurrence. Depending on the concept, virtual reality is based on both elements of the real world and fiction. Jaron Lanier is considered as the creator of Virtual Reality, who together with Steve Bryson, defined the virtual reality in the following words:

"Virtual reality is the way to use computer technology to create an interactive, 3D world, in which objects give the impression of spatial presence".

The analyzes carried out on the development of the virtual technology market show increased interest in simulation services in the military, aviation, medical, mining and education industries. Most of the information from the environment is collected by the human through the sense of sight, simulations - affecting this sense intensively - give the greatest opportunities in the learning process [1].

The presented research results show that teaching using simulation and multimedia presentations takes less time. Virtual reality will become an increasingly detailed reflection of the physical world, becoming part of it. VR technology allows a better understanding of the training material laid out. It also allows you to visualize the effects of individual actions. Knowledge acquired in this way is absorbed faster and remains in the memory for longer. We can observe dynamic development of VR in education [2].

3. *Human competences in VR*

Professional competences are understood as the characteristics of a person, enabling efficient performance of professional tasks. The problem of the type and impact of competences has been in the center of attention of labor market

researchers for years. Three components are traditionally distinguished in the competences - knowledge, skills and attitudes. Therefore, competence means knowledge about a given activity, the ability to perform it and a set of attitudes determining the high quality of business (e.g. in accordance with the principles of professional ethics, punctual, adequate to customer needs).

Virtual reality has significant use in the military. It is ideal for training soldiers in combat who can practice their habits. You can do this in a safety environment and control all its conditions. The virtual reality solutions are also important in the diagnosis of neurological and psychiatric diseases or rehabilitation after strokes. Tests with using VR, carried out with soldiers who suffer from post-traumatic stress, show that the human brain provide opportunities for rapid regeneration. Introducing VR tools is inevitable. The educational systems needs the new challenge.

4. How is VR used by the military?

VR is used by the military in all three major fields – ground, air and navy forces for flight and battlefield simulations, medical training as well as vehicle simulation.

For example, the British army site shows a 66% increase of interest in professional armed forces training within last year. A virtual program covering 4 scenarios: tank service on the Salisbury Plain, skydiving at the RAF Brize Norton base, climbing the Crib Goch ridge in Wales and combat training at the Salisbury training ground.

The second example is in a classroom at the Armed Forces Reserve Center in Austin, Texas began its VR training experiment with 20 pilot students — 15 officers and five enlisted airmen without college degrees. Thirteen of those students accomplished the course in four months time, which normally takes an entire year.

This example shows that buyers should be more open to the future technology which is a good choice. The main issue is what will be better for use to at study. Commercial off-the-shelf VR headsets, like the Oculus Rift, or chose the VIVE Pro because its organic light-emitting diode display has the best resolution. The technology is getting better all the time.

In expert opinion VR training is a much less linear way to learn than the traditional model which usually has a set year-long syllabus of one lesson after another that must be followed. But in this method, instructors can match the lessons to each individual student needs. That means, if a student is a natural at one flight technique, but is lacking in another, the instructor can concentrate on the student's deficient skill and not waste time on something he's already good at [3].

Aviation on the modern battlefield is the most effective but the costs of training a military pilot is very expensive. The success of air missions and, as a result, the defense of the country in the air, on land and at sea depends on their training and equipment. Training of a fighter pilot costs from about 6 to 8 million dollars. Most Polish pilots, especially jet aircraft, undergo appropriate training abroad. This is associated with large expenses, with appropriate policy and

equipment development. Observing the current situation in the Air Force there is a need to place great emphasis on pilot training using new technologies that are widely used in the world.

5. *Flight deck operations training*

Amongst all kinds of aviation, naval operations stand as some of the most demanding in all aspects, both for the aircraft and personnel involved in their operation. When focusing on personnel, high skills held by flight crews are especially respected, for its job comprises safely returning million-dollar machines to narrow platforms floating in middle of the often rough seas. This kind of flying requires intense specific training which, up to some extent, can be performed in advanced full-motion simulators recreating almost real conditions and, hence, saving large amounts of money.

Nevertheless, in the other side of the maneuver, flight deck crews carry no less responsibility, in charge of providing pilots with instructions, moving and fixing aircraft on the deck, refueling, handling ammunition, etc., as well as the danger inherent in operation. So here comes the main point of the present technology. Unlike pilots, whose environment consists of an enclosed area, where everything needs to perform their critical tasks is at the reach of the hand, flight deck crews are *inside* this outside environment, interacting with it directly with their bodies rather than through flight controls.

Unfortunately, both of these roles involve the same: aircraft operation, and both of them require extensive training in order to assure complete safety. Thus, making flight deck crew training a necessary and expensive issue, as the possibility of skipping the use of real aircraft had never existed until now. The development of virtual reality as a mature technology has to make feasible, to certain extent, the interaction between human and flight deck operations in an advanced way. Immersion in a completely virtual environment, as well as an incipient utilization of other parts of the body thanks to gesture recognition, enables to replace operations involving a real aircraft until the very last stages.

6. *Trends in commercial aviation*

Many organizations in the aviation training sector are trying to quickly adapt to the challenges of responding to the new commercial aviation participants. Increase in demand means that with the development of the flight crew members, the main problem is with effective training methods in all fields of aviation.

Current EASA initiative is focused on new training principles for virtual reality. Only several companies use VR to aviation simulators. One of them is Czech interactive simulation solutions. The combination of Oculus Rift head displays and Leap Motion controllers with D-BOX seats and motor devices rendering the landscape, that the new BIS simulator takes into incredible virtual sensations such as: every aspect of flight, engine roar and turbulence vibrations. The use of VR is also recommended for the development of tools to support management knowledge. In opinion Nick Careen, IATA's Senior Vice President for Airport, Passenger, Cargo and Security claims, (...) "innovative technology

is the key. VR in the learning context increases knowledge retention by as much as four times while improving motivation and engagement (...). It is proven that approximately 70% of memory from training is lost within the first 24 hours if there is no attempt to retain it ('Forgetting Curve', Herman Ebbinghaus). In training, an effective method of retention is the immediate application and repetition [4]. According to the IATA recommendations described in the White paper document, training can be reduced by 25%, while increasing the retention of knowledge of its training participants 4 times [5]. This is what VR can bring to organization when it is successfully implemented in the training program.

One of example is the successful implementation of VR technology in groundhandling training via the RampVR platform. Fraport Ground Services company has integrated VR training in new and existing employees on the ground. Some of them had a basic course as new employees and about 70 % of the students had a refresher course. Students remembered the procedures far better and retained them for a longer period, which at the end gives an improved performance quality. The ramp environment is noisy and full of frequent obstacles which can disrupt training. The hazards and risks associated with training on the ramp can be reduced in a VR where the trainees remain in a controlled office environment.

The feedback received from all students involved in the project was extremely positive and an ongoing use of the VR tool is very much favored in the future.

The civil aviation has been witnessing strong growth lately. One of the major factors driving this growth is the increased demand for aircraft and more experienced employees. VR is a good market which can help in developing those particular skills among new members of the aviation world.



Fig. 1. Attractive Opportunities in Augmented and Virtual Reality Market in Aviation

(Source: <https://www.marketsandmarkets.com/Market-Reports/ar-vr-aviation-market-230427667.html>, date: 19.11.2019)

The EON Reality the world leader in Virtual and Augmented Reality based knowledge transfer for industry and education. They developed a series of applications for the company that guided both the pre-flight checks on a Boeing 777 and on ground crew procedures for a landing aircraft. These offered modules run on iOS or Android phones and tablets in either 2D or VR modes. Students can get realistic practice of parking a jet at a terminal and actually take the necessary steps to get a 777 ready for take off. Their progress is tracked and sent to a Learning Management System. It is good solution to understand how the students are performing and who needs more practice. VR training allows tracking the students performance, not just the final result. This gives the management a granular view of their activities and can correct problem in procedures before they become bigger. Realism gave in the application is important because it can be to integrated into current training programs. The use of mobile phones and tablets as the device of choice means that the pilot can quickly expand to an enterprise wide solution, as no special hardware will be required [6].

7. VR training in the Air Force University in Dęblin

In Air Force University there are many types of simulators for pilots but in last year Faculty of Aviation Safety implemented new educational tool as VR for training cabin crew in two languages version pl. and en. Students can take the part in safety training on board virtual Airbus A321. Previously they studied only in the theory and some activity on board of real old Russian aircraft. New technologies bring students close to real working conditions on board an aircraft using in civil aviation.

Four groups of students took part in the research:

- a) civilian study at the Aviation Safety Faculty (under 25 years old, 60 students);
- b) foreign pilot cadets from Aviation Faculty (under 25 years old, 15 students);
- c) mix foreign group navigation and pilots cadets from Estonia, Romania, Greece, Poland (under 25 years old, 12 students);
- d) officer's course of the airport fire fighters (people over 25 years old, 13 persons)

They had two different training to pass. First it was searching of dangerous goods on board of the aircraft and the second one was checking the emergency equipment.

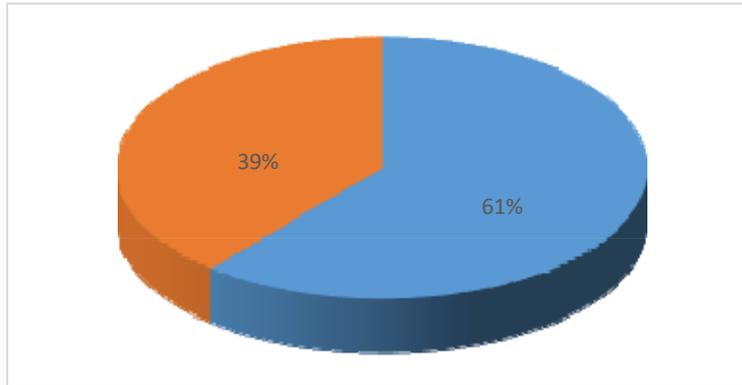


Fig. 2. Students participated actively

A 61% of the participants did not have contact with VR tools beforehand but they worked very actively and they were focused on accomplishing the task. 39% they had some contact with VR but only with games. All of them had a distance because they were afraid of new solutions. They needed some kind of motivation from teacher. The bigger problem was noticed in the group d) because for them the new tools is kind of new challenge. The younger people are more open to new methods of teaching because they have regular contact with computer and IT tools, such as games.

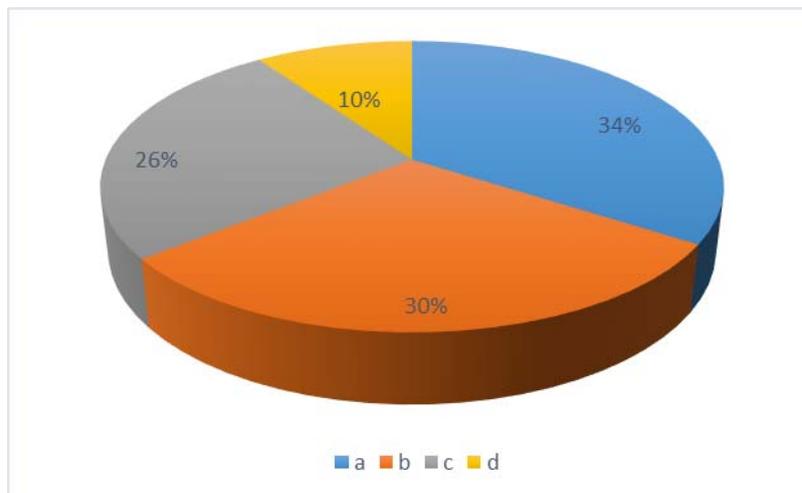


Fig. 3. Quality of completed tasks

Second part of research checked the quality of tasks performed during searching dangerous goods. In the first group a) the students were very serious, most of them had first time contact with aircraft and they were more motivated to achieve the goal because they study at the Aviation Safety Faculty. The problem was with limited time and too many students. The second group b), they represent a special small and closed group, they know each other very well. They did the training very ambitiously and well quality in 30%. The c) group was very experience and good active in this exercise. They were very logical, fast thinking and did the task very precisely in 26 %. The last of the

group was d) and there were only few of them who wanted did this exercise very well what gave only 10 % quality.

Conclusion of this research is that the result of using VR in education depends on group of people who is it dedicated to. A lot of them have a problem when they put the googles on their head and then they lose the eye contact but still can hear the rest of the group.

All groups have particularly positive feelings about the feasibility of building functions of various devices connected on board. Percentage of their feelings are presented in Chart 3. Possibilities of opening traps and controlling emergency equipment with marking on virtual cards were good experience and meeting expectations in performed tasks.

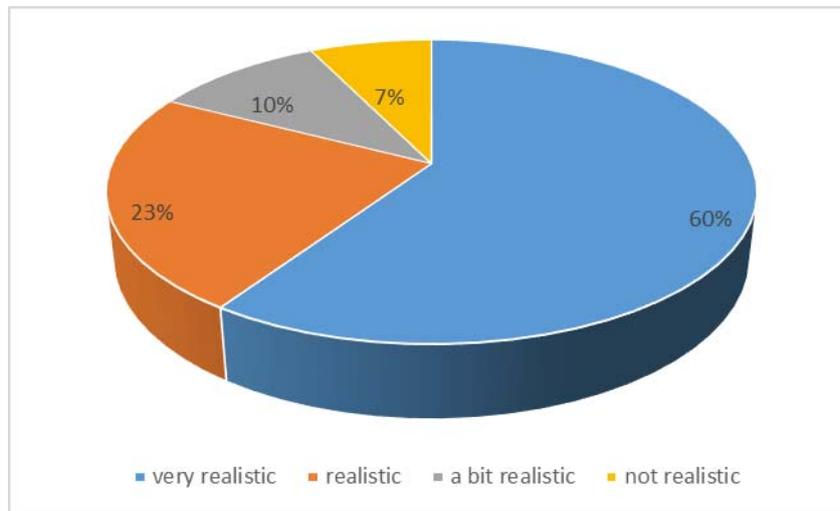


Fig. 4 How realistic was the VR session

The flight crew safety procedures includes the *cabin sweep*, which means checking the security of the deck consists of the available seats on the aircraft that can potentially be used to place hazardous materials. *Cabin sweep* is performed by the flight crew as soon as they board the plane and when they leave the board. This is one of the procedures at airlines to improve the quality of safety. These procedures are associated with the control of emergency equipment, divided into sections. After completing the *cabin sweep*, crew members give the report to the head of the deck, who passes it to captain.

Cabin Sweep procedures should be made [7]:

- in the passenger compartment, space under the seats, tables, pockets and exactly where the life jackets are placed.
- around exits.
- spaces in buffets, places next to the door, around the jumpseat, waste containers, storage compartments, spaces behind catering trolleys
- in toilets - all storage spaces.

The new project also is developing in other modules as fire fighting and ditching [8].

The main response in this work is safety on board. On the course the cabin crew practice all safety and emergency procedures. It can be more effective if they use the VR tools in this case. The work is divided into several tasks to be carried out, modeled on procedures in the airlines. It is very important for students to be well prepared for work in the aviation area. In the research the quality of conducted classes using VR the author founded the benefits and disadvantages in the education technique. Virtual reality is changing the way train the students and employed through these advantages [9]:

- gives positive economic aspect and easy access to the aircraft cabin (laboratory),
- safety environment in activity
- awareness of the tasks performed
- increased productivity
- saves time and money with remote learning
- works for various learning styles
- makes training enjoyable and engaging

Civilian and military students took part in this experiment. Many of them focused on the quick effect, but sometimes there were problems with the VR program working, which frustrated them. New technology for global scale, often do not yet meet the needs of the market. However, the development of new solutions is dynamic and we can aspect for quick results. Of course some of them had problems with orientation in natural environment and with VR sickness". The research result is that new technology needs more human work to improve training techniques with the virtual world. The difference between virtual reality scenarios and traditional simulations is the sense of immersion. The virtual environments also make possible training with hazardous materials or dangerous situations as aircraft-failure, without being in a real danger. Virtual reality is still an emerging tool for enterprise and academy learning. This is a good direction that requires greater commitment from science and industry.

8. Conclusions

VR gives great possibility in the field of education, especially useful for: providing real experiences influencing the student's creativity as well as the ability to visualize difficult emergency environment. Students have an easy way to gain very important practical knowledge in the aviation safety area. The modern University and flight companies have in offer traditional and modern VR training program. They achieve better work results and economic profits. New era in training system is cooperating with new technology, it is the main direction in educational field. The first aim is safety environment for students.

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