institute of aviation
warsaw, since 1926

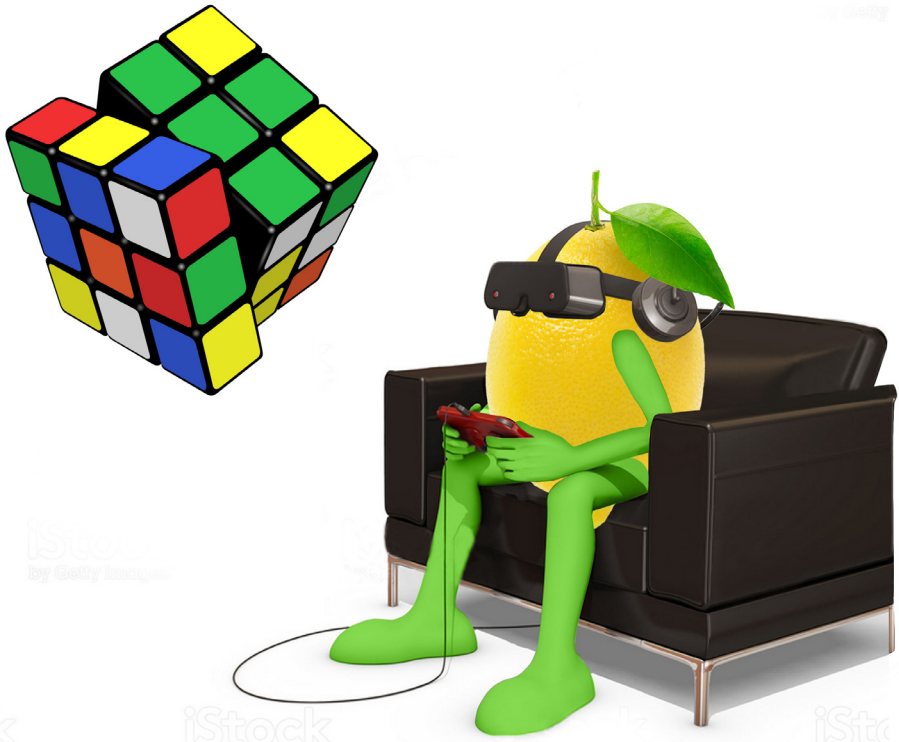
minib 26

marketing of scientific and research organizations

no. 4(26)/2017

research for future

eISSN 2353-8414
pISSN 2353-8503
december 2017



DEVELOPMENT OF VIRTUAL REALITY TECHNOLOGY IN THE ASPECT OF EDUCATIONAL APPLICATIONS

Open Access

DEVELOPMENT OF VIRTUAL REALITY TECHNOLOGY IN THE ASPECT OF EDUCATIONAL APPLICATIONS

Małgorzata Żmigrodzka, Ph.D.
Polish Air Force Academy, Poland
m.zmigrodzka@wsosp.pl
DOI: 10.14611/minib.26.12.2017.15

Summary

In the recent years we have observed the development of devices and visualizations for monitoring the activity of a user (movement and position) in a virtual environment[1]. Along with the growing utilization of personal computers for visualization and rapid development of computer image generation in real time, universities, following the latest trends used in science, are looking for solutions to reach students through the senses of: sight, hearing and touch[2]. We should take into consideration the diversity of students' styles and strategies of learning, that's why the use of virtual reality (VR) in education is a response to the characteristics of the current age. Student as a creative maker and not just a passive recipient deliberately looks for new techniques of acquiring information and thanks to them he or she can build many precious skills, among others, independence in planning or carrying out a task, or cooperating in a team. In this context it is necessary to inform students about research, which is an integral part and foundation for understanding the processes taking place in course of team work e.g.: in aviation. The goal of the article is an attempt to assess the influence of virtual reality technology on education in the 21st century.

Keywords: virtual reality, VR, education, new technologies

Introduction

The 21st century has been characterized by a high pace of development, especially in the area of new technologies. Digital economy strives to popularize the technology of artificial intelligence, which will accompany us in daily work and entertainment. Information will be the main resource and the most important competence will be the ability to aggregate and process information. New information technology solutions, which will change the way people live, are a priority for Poland, as it is an opportunity to implement innovations, investments improving for the society the possibility of using new telecommunication services.

Digitalization and multimedia in the recent years have become a source of communication, information and knowledge. This reality gives rise to new challenges also for the scientific-didactic personnel. Traditional methods seem not just archaic, but also unreliable, that's why university managers following new trends in education eagerly introduce new technical solutions such as virtual reality. What may help understand the position and significance of new technologies in education is the SAMR[3] model developed by Dr Ruben Puentedura. It is necessary to emphasize that the role of the lecturer is still very important, because it should focus above all on the position of a mentor, professional advisor, work organizer, expert on knowledge and efficient learning. The key to an optimum utilization of the available technology in class for educational purposes is the knowledge of the teacher and his, or her experience in the area of tools he, or she can use in teaching. SAMR model describes four levels of introducing new educational technologies in didactics, it allows better understanding of how we use modern tools and what would be better if we used them. SAMR is short for first four letters of the following words:

- Substitution,
- Augmentation,
- Modification,
- Redefinition[4].

This model, on the one hand describes various ways of using technology in teaching and on the other hand shows in what way the most constructive change in the educational process takes place.

The goal of this article is an attempt to assess the impact of virtual reality technologies on education in the 21st century. It is proving that conducting classes using the latest technologies raises the efficiency of learning, as it activates to an equal extent both brain hemispheres: left hemisphere which absorbs verbal content and is responsible for analytical thinking and the right hemisphere, which receives emotions, images and is responsible for creativity, spatial imagination and abstract thinking.

In times of development of new technologies it is not enough to have computers, interactive boards etc., as there is a need to stimulate the imagination of the recipient, to take him, or her into virtual reality, experiences helping him, or her enter a new environment. Student, on the basis of images alone, isn't always able to imagine how he will be able to behave in a particular workplace.

The origin of virtual reality

One of the first research projects concerning the way the brain processes two-dimensional images was conducted by Charles Wheatstone in 1838. Already then it was shown looking at stereoscopic photographs, or photographs by means of a stereoscope gives the feeling of depth and immersion. The rules of stereoscope design are used now in popular Google Cardboard screens and low-budget VR displays for smartphones.

Another very important event was when Edward Link built and patented (1931) the first commercial flight simulator, which was completely electric and mechanic. It was controlled by engines which connected to the control surfaces and the steering column to modify the stroke and the roller. The small device powered by an engine simulated turbulences and disruptions for the purposes of training military aircraft pilots in the USA. During World War II over 10,000 "blue box" Link Trainers were used for the preliminary training and the improvement of skills of over 500,000 pilots.

Picture 1. Flight simulator — "link trainer"

Source: http://wskg.org/uncategorized/link-the-quite-genius/ [accessed: 12.09.2017 r.]

Already in the 1930's, thanks to Pygmalion's spectacles — invented by Stanley G.Weinbaum the user could experience a fictional world through holography, smell, taste and touch. Looking back in time, the experience described by Weinbaum for those who wore the glasses is like the current, emerging experiences from virtual reality. This makes Weinbaum a real visionary in the area of technological development. In the interwar period new possibilities emerged. They focused on the experiences with the image of illusion. In the middle of 1950's creator Morton Heilig developed Sensorama, that is, analogue virtual reality (Picture number 2). The invention patented in 1962 was a theatre wardrobe, which stimulated all senses, not just eyesight and hearing. Sensorama contained stereophonic speakers, stereoscopic 3D display, ventilators, smell generators and a vibrating chair. Heilig wanted to immerse a person in a movie.

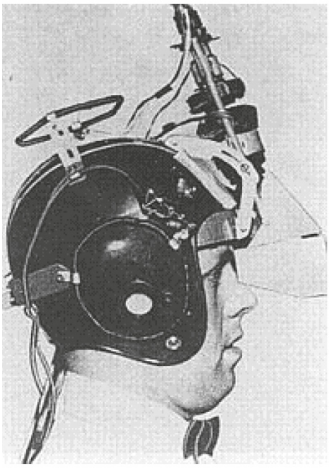
Another invention by Morton Heilig was the telesphere mask (patented in 1960), which was the first example of a head-mounted display (HMD) without the possibility of tracking movement. The headset provided 3D display and wide-angle display with stereo sound.

In 1961 engineers from Philco Corporation (Comeau & Bryan) developed the first HMD now known as Headsight (Picture number 3). The device gave the possibility of linking video screen for each eye with a magnetic movement tracking system, which was connected to a remote camera.

Picture 2. **Sensorama**

Source: http://www.retronauta.pl/sensorama-analogowa-rzeczywistosc-wirtualna, [accessed: 21.09.2017 r.].

Picture 3. **1961 — Headsight**



Source: https://www.sutori.com/item/1961-headsight-developed-by-comeau-and-bryan-the-headsight-projected-screen-f, [accessed: 12.08.2017 r.].

However, the system developed by engineers Comeau and Bryan wasn't a virtual reality system due to the lack of computer simulation, but it was the first step in the evolution of VR HMD. Head movements allowed transferring the image from a remote camera, which made it possible for the user to naturally look at the surrounding environment. In the following years Ivan Sutherland introduced the impression device as a 3D image. Three-dimensional images can be created with stereoscopic and non-stereoscopic techniques and among them the most advanced technique is the hologram technique[5], currently used in cinemas and on mobile vision devices.

In 1969 Myron Krueger, creator of computers with virtual reality developed a series of experiments he called "artificial reality". His projects (*glowflow*, *metaplay and psychic space*) are based on the phenomenon of immersion, which took the artistic form of video installations and interactive cinema. This technology allowed mutual communication in a friendly environment generated by a computer, regardless of the mutual distance[6].

The term Virtual Reality (VR) was introduced in 1986 by an intellectual and artist Jaron Lanier, who defined VR as a technology stimulating the senses, causing the illusion of presence in digitally created spaces. In the following years companies dealing with the development of games competed with innovative products. One of them, which conquered the games market, was Nintendo Virtual Boy console (originally known as VR-32). The 3D game console was presented as the first portable console with the capacity to display real 3D graphics. In 1999 the movie by Wachowski brothers — Matrix — set a new direction for virtual reality. The movie showed characters living in a fully simulated world. Even though some earlier movies, such as Tron from 1982, showed virtual reality, it was Matrix that had a huge impact on culture and introduced the subject of simulation to the main stream[7].

Global access to smartphones brought new opportunities to individual clients, who can use games and other mobile applications. For example, Google has produced temporary material devices for virtual reality (Google Cardboard), DIY headset, which can be used with smartphones. Next, Samsung took this concept further with the Galaxy Gear devices, which are

mass produced and offer such intelligent functions as, for example, gesture control.

The development of VR accelerated in 2012 thanks to virtual reality goggles Oculus Rift (Picture 4), invented by Palmer Luckey — a teenager who used existing solutions adding a few own ideas.

Picture 4. **Gogle Oculus Rift**

Source: http://www.gry-online.pl/Galeria/Html/Wiadomosci/197901994. jpg [accessed: 20.09.2017 r.].

Virtual reality and education

For decades psychologists investigated video games as a model of internally motivated learning. Techniques such as: mechanisms of control, challenge, interest, cooperation, or competition are the basic elements of the theory of motivation[8]. Within an effective learning environment based on educational games a student works to achieve a certain goal, making various decisions along the way and accepting their consequences.

The basis for the understanding of VR technique in education is learning about the systems which allow a human to see on the goggle (headset) display a simulated environment and the device tracks his movements and reflects them in virtual reality. In other words, this is a kind of immersion in the created world.

From the technical perspective, to immerse in the virtual world you need the so-called game engine, which deals with the interaction between the elements of a game. The engine may contain modules of graphics, input,

network, or artificial intelligence — AI. It is most often developed with the use of object paradigm, in which programmes are defined by means of objects — elements connecting *state* (that is, data, most often called fields) and *behaviour* (that is, procedures, methods). The market of new technologies is very strong and is growing dynamically. However, following new trends, producers of game engines compete with the inventiveness of new software applications. Generally, on the global market of new technologies, two engines from the leading brands deserve particular attention. An example of such an engine is Unreal Engine created by Epic Games. Its main features are simulation of physics, possibility of animation, artificial intelligence and the possibility of adding various algorithms.

The second engine which can be applied on a large scale is Unity 3D, a product of the global platform Unity Technology, which is very popular around the world as an integrated environment for creating three-dimensional and two-dimensional computer games, or other interactive materials, such as visualizations, or animations. This system is very often used by individual users and allows creating applications for Internet browsers, personal computers, video game consoles and mobile devices. This suggests that new technologies are available for every average user.

According to the latest statistical data reported by the Virtual Reality Brief portal, almost 80% of educators have access to virtual reality devices, but they are used by merely about 6,87% of the recipients. Virtual reality technologies are very dynamically entering the world of science, but at the same time worries concerning new teaching techniques keep emerging. What may be the reasons for such an approach are the lack of knowledge about the advantages of VR, or the lack of concept for the implementation of teaching resources. Experts have observed the need to introduce virtual reality to education. Delivering by means of VR experiences which are compatible with the material delivered during lectures is actually advisable. Scientists dealing with VR education should consider the benefits from the development of experiences which reflect and support the existing teaching programme, instead of creating exotic, individual experiences.

Technologies augmenting our reality, creating new realities, or combining them are available already now. The main potential of education

based on the technique of augmented reality can be found in the VR method — imposing computer-generated information on real objects and work on virtual objects in a real environment.

Education in combination with VR allows creating artificial laboratories in which you can conduct research — both amateur (for the purposes of teaching in schools) and professional research (for scientific purposes).

Examples of virtual reality used in aviation training

The most obvious application of VR in the aviation industry is training. Flight simulators have been used for years and can be used also at home. In professional space companies such as Boeing have created simulators on the basis of the structure of a real aircraft cockpit, replacing windows with screens. However, as a training tool simulators are expensive and inconvenient. Now companies using VR technology strive to modernize simulators. What deserves particular attention are Czech interactive simulations, which have been used for years both on the home and professional market. The combination of headset display Oculus Rift and Leap Motion[9] controllers with D-BOX[10] seats and own engine rendering the landscape allow the new BIS[11] simulator to deliver amazing virtual experiences, which precisely mimic every aspect of flight, from control to turning engines on and off with sound effects, as well as vibrations during turbulences.

One of aviation organizations uses VR to help train not just pilots, but also flight attendants and ground personnel. Future Visual company during a symposium of the International Air Transport Association (IATA) presented a concept of training the personnel of airlines in the area of external inspection of aircraft. Using Oculus Rift headset display the participants could walk through the whole process of inspecting an airplane before flight, looking for defects, or technical problems and later could locate security equipment inside the plane.

Virtual reality is appreciated more and more by the scientific community. Every area of science deals with issues which should be investigated, in a tangible way. Thanks to new technologies students can

experience, among others, remote places, which would be too expensive, if they had to go on a field trip. For example, thanks to VR, students can take part in a virtual trip to an airport to see airport infrastructure and learn about the organization of work at the airport. VR provides limitless opportunities of moving to places which are normally inaccessible, such as space etc. There is evidence that VR experience differs a lot from other learning techniques, as it establishes an emotional link between the student and the subject of classes. Experts suggest that information delivered by VR is more easily absorbed and stored by the human brain.

Up till recently virtual reality technologies used on a large scale were known from applications in the military and medicine. Now their value has been appreciated also in security, ergonomics and mining. New technologies are used for various kinds of simulations and personnel trainings for the occasion of emergency situations. VR training is particularly useful when trainings in natural conditions may pose a threat to health and life of the participants.

One of the products offered by the producer of simulators — EDM[12] from Great Britain — are virtual reality headphones used to train cabin crew to satisfy the growing demand from airlines for modern technology. Headphone sets can be used together with the existing EDM models of airplane fuselage. EDM's offer includes also aircraft door replicas, so that flight attendants can be trained how to open the door in case of emergency situations and in normal situations. Trainings for crews using a VR simulator (Picture number 5) have shown that it improves memory and boosts concentration and at the same time simplifies complex training scenarios. VR training offers a pleasant way of learning, which allows greater engagement and understanding of the subject during the training, taking into consideration various styles of learning and skills.

EDM is planning to launch also an innovative WATS[13], application, which allows aviation training professionals to design quickly and easily simulators for training cabin crew, which satisfy their requirements. The first version of the application makes it possible for the users to configure a door simulator and the improved version is supposed to make it possible to design cabin simulator and cabin evacuation simulator, as well as a real Fire Train simulator for every type of airplane.

Picture 5. Training for personnel using a VR simulator

Source: http://www.adsadvance.co.uk/media/images/2017/EDM%27s%20VR%20Door%20Trainer.jpg, [accessed: 13.09.2017 r.].

One of important elements of the crew's work is communication. You can work out techniques of good communication through appropriate training, also by using virtual reality. What deserves particular attention are team tasks, which can be created in VR tools to address the planned tasks. A good example of this is the product of 1000 realities[14] — Blockade, which boosts awareness, facilitates diagnosis and the understanding of barriers to effective communication within the crew.

Another example is Osterhout Design Group with headquarters in San Francisco (ODG) which has recognized the potential of VR technology not just for in-flight entertainment but also for the safety of passengers. VR could help passengers in emergency situations with virtual step-by-step instructions. An important application is also the use of intelligent glasses by the members of cabin crew in case of threat to health and life. Wearing intelligent glasses with access to the Internet the cabin crew can consult a medical emergency on board of an airplane with a doctor on the ground thanks to the function of videoconference. Such a possibility makes it much easier for the captain to make decisions in acute medical emergencies[15].

Virtual reality simulators are already used for training programmes for ground staff working at airports. Under hard weather conditions such as: snow, ice, frost, cold rain, wind, etc. trainings with the utilization of new technologies are a perfect solution for the team responsible for ground aircraft maintenance. For example, cleaning the tarmac, and de-icing airplanes requires the work of many people responsible for airport traffic and the flight of an airplane itself.

Picture 6. Aircraft de-icing operator training simulator

Source: http://forgefx.com/simulation-projects/aircraft-ground-support/deicing-training-simulator/, [accessed: 14.09.2017 r.].

The process of de-icing an airplane consumes a lot of time, costs a lot and is hard for new employees. This means, there is a need for simulators which can be used on the basis of a computer, two joysticks and a tv screen. The configuration of appropriate algorithms reflecting interior of the cabin for de-icing and fluids which have to be used under particular weather conditions, generates much smaller costs and scales down all de-icing operations. The participant of a training using the simulator can learn how to properly douse an airplane to avoid the risk of damaging delicate panels and control surfaces. The person responsible for de-icing airplanes can learn in a safe environment about the steering elements and the most efficient ways of de-icing an airplane. Such solutions are already used around the world and the forerunners think that in the future they will bring great benefits, both material benefits and benefits associated with the security of flight operations.

What is a very important element, apart from specialist applications of virtual reality, in almost any area of science and a big professional problem is interpersonal communication, especially in times of new technologies. It is because it is easier to send someone a message, rather than say something face to face. However, it is impossible to fully replace the human factor, as it is human that is the key factor in the management system.

Conclusions

In time of strong competition of educational offers, the biggest challenge for universities concerns changing the model of education for the purpose of adapting it to the individual needs of the candidate. University managers have to find a balance between satisfying programme requirements and satisfying the individual needs of candidates. In a constantly changing world it is important to follow the language of students and understand their needs. Simply delivering knowledge is not a feat. Methods and techniques of delivering knowledge are more important. New technologies are ready for application on a broad scale, however, the biggest limitation for new technologies are people themselves. Some are afraid of losing their jobs, others can't imagine changes.

Managing education, company, society in the contemporary world focuses on adapting the model of management to the current trends on the market. Universities cannot rely only on their brand, they have to be competitive and provide students with new possibilities. An innovative method of teaching should encourage acquisition of knowledge and the will to actively participate in classes. After graduation the student should feel comfortable entering the professional community within the areas he studied during classes.

References

[1] Scientific-research works of the institute of mathematical machines, rok XXXIII, nr12, 2009.
[2] B. Wolny, Nowoczesne technologie w edukacji jak uczyć skutecznie i efektywnie, Ośrodek Rozwoju Edukacji, 2002 r.
[3] http://www.edunews.pl/badania-i-debaty/badania/2736-model-samr-czyli-o-technologii-w-nauczaniu
[4] Ibidem.
[5] M.P. Sadowski, Hologramy i holografia, UW, Warszawa, 2005 r., s. 20.
[6] http://www.techsty.art.pl/hipertekst/cyberprzestrzen/krueger.htm, [accessed: 25.09.2017 r.].
[7] https://www.vrs.org.uk/virtual-reality/history.html, [accessed: 20.09.2017 r.].
[8] http://ec.europa.eu/programmes/proxy/alfresco-webscripts/api/node/content/workspace/SpacesStore/3233b05b-4f5b-47bb-a926-2cad6ffbbe1d/manual_pl.pdf
[9] https://www.leapmotion.com, [accessed: 20.09.2017 r.].
[10] https://www.pcworld.pl/news/3D-to-juz-za-malo-ruchome-fotele-D-Box-ratunkiem-dla-upadajacych-kin, 370853.html, [accessed: 12.09.2017 r.].

[11] http://www.covidien.com/imageServer.aspx/doc278104.pdf?contentID=77506&contenttype=application/pdf, [accessed: 12.09.2017 r.].
[12] http://www.edm.ltd.uk/edm-launch-virtual-reality-cabin-crew-training-simulators-wats-2017/, [accessed: 19.09.2017 r.].
[13] https://play.google.com/store/apps/details?id=com.virinco.wats&hl=pl, [accessed: 23.092017 r.].
[14] http://www.1000realities.pl, [dostęp: 13.09.2107 r.].
[17] https://apex.aero/2015/11/18/virtual-reality-in-flight, [accessed: 23.09.2017 r.].

Bibliography

1. William, W. (1993). *A Conceptual Basis for Educational Applications of Virtual Reality*. University of Washington.
2. Bierbaum, A. *Virtual Reality Appl. Center*. Iowa State Univ., Ames, IA, USA.
3. William, R. Sherman, Alan, B. Craigm (2003). *Understanding Virtual Reality: Interface, Application, and Design*, USA.
4. *Prace naukowo badawcze instytutu maszyn matematycznych*, rok XXXIII, no 12, 2009.
5. Sadowski, M.P. (2005). *Hologramy i holografia*, UW, Warszawa.
6. Wolny, B. (2002). *Nowoczesne technologie w edukacji jak uczyć skutecznie i efektywnie*. Ośrodek Rozwoju Edukacji.

Internet sources:
7. http://www.techsty.art.pl/hipertekst/cyberprzestrzen/krueger.htm,
8. https://www.vrs.org.uk/virtual-reality/history.html,
9. http://ec.europa.eu/programmes/proxy/alfresco-webscripts/api/node/content/workspace/SpacesStore/3233b05b-4f5b-47bb-a926-2cad6ffbbe1d/manual_pl.pdf,
10. https://www.leapmotion.com,
11. https://www.pcworld.pl/news/3D-to-juz-za-malo-ruchome-fotele-D-Box-ratunkiem-dla-upadajacych-kin, 370853.html,
12. http://www.covidien.com/imageServer.aspx/doc278104.pdf?contentID=77506&contenttype=application/pdf,
14. http://www.edm.ltd.uk/edm-launch-virtual-reality-cabin-crew-training-simulators-wats-2017/,
15. https://play.google.com/store/apps/details?id=com.virinco.wats&hl=pl,
16. https://apex.aero/2015/11/18/virtual-reality-in-flight,
17. http://www.edunews.pl/badania-i-debaty/badania/2736-model-samr-czyli-o-technologii-w-nauczaniu.

Małgorzata Żmigrodzka, Ph.D., Polish Air Force Academy, Poland — Ph.D. in social sciences in the field of political sciences. She gained professional experience in aviation in state and commercial companies providing services in air transport, including: LOT Polish Airlines, 36th Special Regiment of Aviation Transport (currently 1st Airlift Base), AIRPOLONIA, *Nowy Przewoźnik* — *Centralwings* (PLL LOT group). In 2011–2012 she associated her passions and aviation experience with facing new challenges in European Funds, implementing tasks in the area of development of air infrastructure promotion. Raising her professional competences, she took an active part in conferences on aviation science. She is currently employed at the Polish Air Force Academy in Dęblin. The author's research interests include safety issues in air transport and the application of new technologies at the airport.

Institute of Aviation
Scientific Publishers
al. Krakowska 110/114
02-256 Warsaw, Poland
phone: (+48 22) 846 00 11 ext. 551
e-mail: minib@ilot.edu.pl

www.minib.pl
www.twitter.com/EuropeanMINIB
www.facebook.com/EuropeanJournalMINIB