DEVELOPMENT OF A MOBILE GAME BASED ON VIRTUAL REALITY TOOLS TO SENSITIZE THE POPULATION ABOUT THE NUCLEAR POWER PLANT'S EMERGENCY PLAN.

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ABSTRACT

The Angra dos Reis Nuclear Power Plant's emergency plan, it´s the bunch of instructions that every citizen must adopt in case of an emergency situation. It's highly important, that all the people living in the power plant´s surroundings truly understand every single step of the plan, because only in this way people will know how to react in case of a necessity. To hit this goals, the Brazil`s Electronuclear, made educational booklets, in the shape of comic books, trying to guide the population about the plan. On the other hand, we have an increasingly connected world, making possible that digital games, be very well accepted by the population. So this project has as an objective, developing a digital tool, in form of a mobile game that shows in a playful and interactive way for the user, the emergency plan, complementing the educational process and social actions made by many institutions. With the information taken from the booklets, objects and buildings were modeled in Autodesk 3ds Max, allied with the Unity 3D Game Engine, to make a city, inspired in Angra do Reis (RJ). The player has to follow all the security protocols giving by the Eletronuclear according with the rules provided by the National Nuclear Energy Commission. Is expected, with this game that will be available for the Eletronuclear that more people have the chance to know and believe in the efficiency of the emergency plan already established.

1. INTRODUCTION

With the growth and expansion of the brazilian's nuclear power plants, is important that the population knows the benefits and safety measures of this type of energy. The Angra dos Reis Nuclear Power Plant's emergency plan is the set of instructions that the citizen should adopt in case of an eventuality. It is imperative that all the people, who live in the surroundings of the plant, know each one of these steps and how to proceed in an unforeseen event. Currently, this type of instruction is obtained by watching education videos or reading educational leaflets, provided by the government allied with the Ministério de Minas e Energia. On the other hand, some people still have many doubts about this source of power and how safe it can be [2]. In this context, it is necessary to raise awareness and inform the population about what is the nuclear energy, as well as the principle of operation of a nuclear power plant and, above all, that there are protocols and safety plans for the operation of the facility itself and to protect the population around in any emergency case.

In order to demonstrate the safety of nuclear power plants, the government does daily tests on all alarms within a radius of fifteen kilometers and once a month, a simulation is performed demonstrating the protocol to be followed in case of a truly necessity [3]. However, in order to promote a more playful, engaging, motivating way of communication and learning, virtual reality technology has been increasingly used. Virtual Reality (VR) is a term used to describe a set of techniques and methods of advanced interfaces, capable of allowing the sensorial integration between users and computers, in order to give the player the maximum sensation of presence in a virtual world, Allowing them to explore and interact with a three-dimensional (3D) environment, using the computer as if it were part of the virtual world.

Looking forward at this new technology as a form of the diffusion of science, the Instituto de Engenharia Nuclear (IEN – RJ) has made many researches [6] using virtual reality tools, principally in the educational area, studying all the difficulties that people has, developing a mobile solution [7], focus on the children and teenagers residing close to the power plants [8] in Angra do Reis, Rio de Janeiro.

In this line of thought, this multidisciplinary and interdisciplinary work aims to use VR technology in a 3D computer game to teach about nuclear energy, its benefits and risks, as well as aspects related to the security of installations and population. To this end, an educational game for mobile devices will be developed, addressing topics such as: nuclear energy, facility security protocol and the emergency plan.

2. METHODOLOGY

The simulation of the emergency plan was developed using all the information provided by the eletronuclear booklets synchronized with the programs: SketchUp Make and Unity 3D Engine allied with the Microsoft Visual Studio Community 2017. The first one was responsible for modeling the entire scenario presented in the game, such as the house and its objects. The Unity 3D Engine was used as the game core, making possible all the actions, movements, controls and the character interaction with the scene. Behind every part of this, Microsoft Visual Studio Community 2017 was used in scripting programming, adding in-game functionalities.

The sequence below will explain how every part of the process was made.

2.1. The Eletronuclear booklets

Eletronuclear has produced educational booklets [3, 4], in the form of comic books, trying to guide the population about the emergency plan of the Angra dos Reis' nuclear power plants. These booklets, fig. 1, were the start point to all the work made in this project. By reading it, was possible to identify an excessive quantity of text, something that is not the best alternative when applied with children. Researching all the booklets highlights, many ideas were discussed. Develop a mobile game was the solution chosen considering the familiarity of these young people with this type of tool. The beginning of the game producer, started by the conception of the character and it's story, based in all the knowledge present on the leaflet. The purpose is to create a tool to simplify and make much more pleasant, the learning of an important protocol.

| (a) | (b) |

Figure 1 (a, b): Two examples of the Eletronuclear booklets. The first one (a) is destined for the people who leave in the power plant surrounds at 3 to 5 Kilometers and the second (b), it's from the people who live at the distance from 10 to 15 Km.

2.2. Sketch Up Make 2017

SketchUp 2017 is complete software used for professional and amateur modelers and designers to create, generally, buildings and its interiors [9]. This Software is a surprisingly, powerful and simple to use tool for creating, viewing, displaying and modifying 3D ideas. Its modeling capabilities enable users to create advanced models with a fast learning curve. SketchUp includes a large number of features, designed to help users create quality models and transfer them to other software, such as game cores, image editors, and more. The fig. 2, shows the exact moment, when the house plant was modeled.
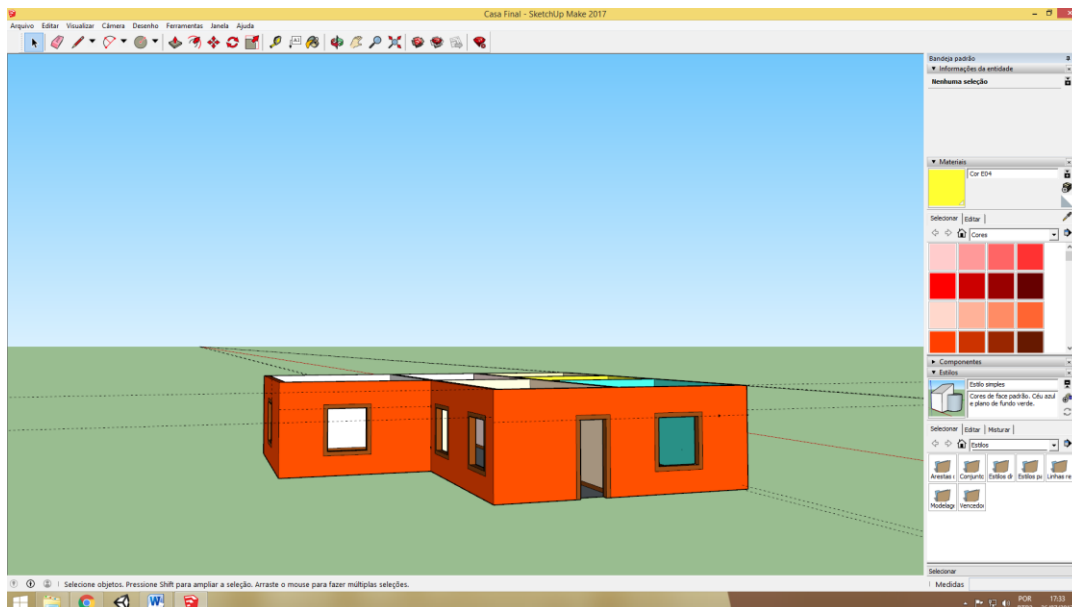

Figure 2: A house similar to the pattern founded in Angra dos Reis, Rio de Janeiro, been modeling to the game.

2.3. Unity 3D Game Engine

Unity 3D is one of the most important game engines present in the development scene nowadays. With a full set of tools, that when combined, can create stunning 3D worlds for many types of game [4]. This engine is very popular because of its easy multiplataform publishing. It can provide games and applications for Pc, Mac, Linux, smartphones, tablets, VR [1], consoles, etc. The Unity has good options of particle and light giving for the work a good visual result, close to the reality. For this reasons, it has been chosen to work with in IEN, being responsible for create all the visuals as the skies, the vegetation and the water presented in the game "O Plano de Emergência", fig. 3. The Unity is widely used in the educational area because of its didactic form, being notable works for simulation based on real experiences in schools, hospital and etc.
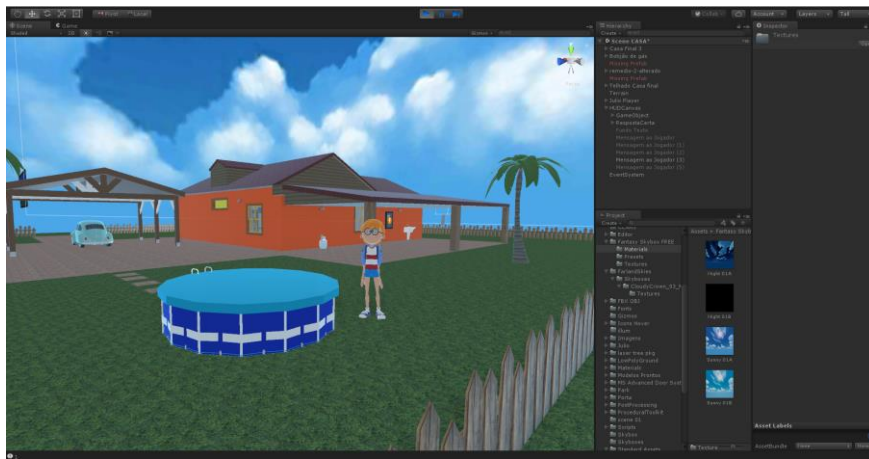

Figure 3: The game "O Plano de Emergência" in the game engine Unity 3D.

2.3.1. Microsoft Visual Studio Community 2017

The Visual Studio is an IDE of code development for many languages. When working with the Unity 3D as it's scripts support, only JavaScript and C# is available to choose. In the project, C# was chosen, and around thirty scripts were developed with it. These codes have functions in the game, to connect the action made by the player with the avatar, fig. 4.
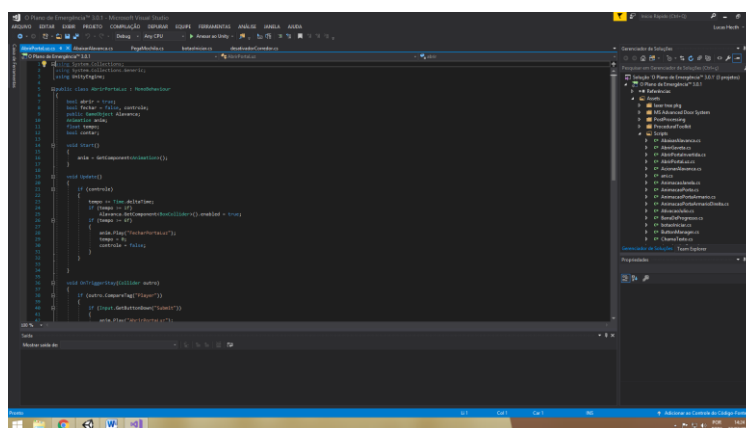

Figure 4: The full integration of Visual Studio Community 2017 scripts with the Unity 3D Game Engine.

2.3.2. Control and Gameplay

The game was developed for mobile platforms, requiring a control to play. This control, known as a joystick (Fig. 5), uses Bluetooth technology allowing the player to visualize the screen more clearly while playing.

Figure 5: Example of the Bluetooth joystick used in the mobile gameplay.

The "A" button is responsible for catch the objects inside house, such as: the backpack, the medicines, the pack of clothes and the documents, that the main character, known as Julio, has to find and put it on his backpack. The "B" button is charged to open and close all the windows and doors, where the character has to pass while playing. The left analogic stick, as usual, is the player's movements.

2.3.3. Main Questions of the Game

Sober elements were design to give to the children, the best experience with saturated color and intuitive icons. It was added to the peripheral area of the game to make the ambient more comprehensive for children.

The HUD, fig. 6, shows for the children every necessary step to complete successfully the game, as examples:

- Catch the backpack;
- Pick the documents folder;
- Take all the family medicines;
- Put tape and cloth in all the windows and doors;
- Goes to the meeting point in Praia Brava, Angra dos Reis, Rio de Janeiro, where the player is going to take a bus with his relatives to go to a safer place.

(a)   (b)

Figure 6 (a, b): The main HUD of the game that shows for the player, what is the next object to seek and find (a), and the textbox (b) shows more detailed information.

2.3.4. Unity Post Processing

Every part of the game was careful made, and so, the game design is a part that has received a lot of attention. For these reason, many documents were read to find a way to get better visual results, and the solution was simple, using a Unity Package called Unity Post Processing [10]. The Unity post-processing stack is a bunch of effects that combines a complete set of images effects into a single post-processing pipeline.

3.   RESULTS

Figures present all the practical result obtained with this research. In the fig. 7 is possible to see Julio's bedroom, with all the elements listed before working together in a harmonic way. The interface's elements combined with the 3D objects modeled created a visual very close to what people used to have in their own homes. With the carry of information, optimization and design, the game runs without problems in most devices.

Figure 7: Actual gameplay of the game "O Plano de Emergência".

Finally, in fig. 8 it is possible to see the game being played on a mobile device with the use of a joystick, that possibility a better movement thru the game. The main character Julio, has to accomplished all the tasks to fully complete the Emergency Plan of Angra dos Reis.

Figure 8: The game running in an Android smartphone united with the Bluetooth Gamepad.

4. CONCLUSIONS

This project represents an strategic option to spread important information about the nuclear energy and its applications for the public. Once, because it's was fully design for the Android Mobile system, that is the most used system at the world [11]. The popularization of this firmware possibilities that games could be make without the need of a computer. In parallel the facility to be incorporated at websites and schools, because its gameplay has easy-to-understand elements, making the children always motivated to play with their friends and family. People nowadays have sources to inform themselves about the Emergency Plan, but is expected that this new form of learning complete and re-force all the instructions that the government has to pass for all its citizens. And being successful, in this idea, would bring new horizons, encouraging programmers and designers to create new solutions, thru the technologies based on the game "O Plano de Emergência".

ACKNOWLEDGMENTS

REFERENCES

1. BLACKMAN, S.; Beginning 3D Game Development with Unity 4: All-in-one, multiplatform game development. Apress, New York, United States of America (2013).

2. CARTILHA ELETRONUCLEAR; Plano de Emergência - Pra você ficar mais seguro; (2015).
3. CARTILHA ELETRONUCLEAR; Zonas de Planejamento de Emergência – 3 e 5; http://www.eletronuclear.gov.br/Portals/0/Pageflip/pageflip_ZPE3_5/index.html/ (2017).
4. CARTILHA ELETRONUCLEAR; Zonas de Planejamento de Emergência – 10 e 15; http://www.eletronuclear.gov.br/Portals/0/Pageflip/pageflip_ZPE10_15/index.html/ (2017).
5. COTELLI, A.; Legey, Ana Paula ; Mol, A.C.A. ; Marins ER ; SILVA, M. . Using virtual reality to support the physical security of nuclear facilities.. Progress in Nuclear Energy (New Series), **v. 78**, p. 19-24, (2015).
6. DA SILVA, MÁRCIO HENRIQUE; Legey, Ana Paula; MÓL, ANTÔNIO CARLOS DE A.. Review study of virtual reality techniques used at nuclear issues with emphasis (2017)
7. Legey, A. P.; Mol, ACA ; LAPA, C. M. F. ; LIMA, T. ; PAULA, V. M. ; LUCENA JUNIOR, I. ; AUGUSTO, H. . DIGITAL GAME FOR EDUCATION AND DISSEMINATION OF NUCLEAR ENERGY APPLICATIONS. In: International Nuclear Atlantic Conference, 2015, Sao Paulo. International Nuclear Atlantic Conference. RJ: INAC, 2015. v. 1. p. 7-15 (2015).
8. Legey, A. P.; PASTURA, V.; Mol, ACA ; Marins ER ; SANTO, A. C. E. . Reflexão sobre a Realidade Virtual como Ferramenta de Educação Permanente nas Instituições Nucleares. Revista Carioca de Ciência, Tecnologia e Educação, **v. 2**, p. 95-106, (2017).
9. OLIVEIRA, Marcos Bandeira de. SketchUp Aplicado ao Projeto Arquitetônico: Da concepção à apresentação de projetos. Novatec Editora: São Paulo. (2015).
10. "UNITY ASSET STORE (POST PROCESSING) "; https://www.assetstore.unity3d.com/en/#!/content/83912/ (2017).
11. The new most used operational system ate the world" https://thenextweb.com/apps/2017/04/03/android-windows-internet-usage/#.tnw_n17bc9im/ (2017).