BACHELOR THESIS & COLLOQUIUM – ME1841038

THE DEVELOPMENT OF FIRE-SAFETY APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

Proposer :
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DOUBLE DEGREE PROGRAM OF
DEPARTMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
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SURABAYA

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SKRIPSI – ME1841038

PENGEMBANGAN PELATIHAN INSPEKSI ALAT-ALAT PENYELAMAT KEBAKARAN DENGAN MENGGUNAKAN APLIKASI VIRTUAL REALITY

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PROGRAM DOUBLE DEGREE
DEPARTMENT TEKNIK SISTEM PERKAPALAN
FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
202

APPROVAL SHEET

THE DEVELOPMENT OF FIRE-SAFETY APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

BACHELOR THESIS

Submitted to comply with one of the requirements to obtain a bachelor thesis engineering degree on :

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Bachelor Program Departement of Marine Engineering
Faculty of Marine Technology
Sepuluh Nopember Institute of Surabaya

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I hereby who signed below declare that:

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Name	:	Aqnil Putra Mahdali
Student Number	:	04211641000009
Final Project Title	:	The Development of Fire-Safety Appliances Inspection Training Using Virtual Reality Application
Departement	:	Marine Engineering

If there is plagiarism act in the future, I will fully responsible and receive the penalty given by ITS according to the regulation applied.

Surabaya, January 2020

Aqnil Putra Mahdali

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THE DEVELOPMENT OF FIRE-SAFETY APPLIANCES INSPECTION TRAINING USING VIRTUAL REALITY APPLICATION

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ABSTRACT

Nowadays, inspection training is still in a conventional way, and the inspector should provide their time and effort to go on-site to conduct an inspection and take a risk or by face to face learning. Considering the not efficient and what is at stake, it is crucial to seek a reliable inspector. Creating competencies and skill for the professional inspector is need many experiences and training. For Conducting inspector training, an environmental simulation based on the conditions of what needs to be inspected is required. Expensive to make environmental simulations and reasons for limited space and time spent on conducting inspection training for surveyors. Virtual reality technology can be a solution to this problem because virtual reality does not become risky and do not takes many costs invested.

This research will start with problem identification, data collecting, analysis phase, creating a virtual object, and Trial Phase. The deliverable of this thesis would be a remotely controllable virtual reality application based android operation system which is the model and design based on the container ship, MV. Meratus Benoa. The application was design with two main modes, which is *Ship Tour Mode* that can bring the user to explore the ship environment and see the explanation of fire fighting appliances and *Inspection Mode* that bring the user to finish a 15 minutes mission to find all the fire fighting appliances in the entire ship and fulfil the inspection checklist. Virtual Reality is beneficial for any sector because it can increase competencies, experience, easy access and easy to use. Based on the objective of this application, it can be concluded that the application can develop and simulate fire safety appliances inspection by making a model of the real condition of the fire safety appliances into 3D modelling and install into a virtual reality application maker. And based on the user questionnaire result, this application in the excellent category because the total value is 364 which is between 360 and 450 (maximum), which is the excellent category.

Keywords*: Virtual Reality, Fire Fighting Appliances, Fire Safety Plan, Inspection Training, 3D Modelling, Inspector*

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PENGEMBANGAN PELATIHAN INSPEKSI ALAT PEMADAM KEBAKARAN DENGAN MENGGUNAKAN APLIKASI VIRTUAL REALITY

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ABSTRAK

Saat ini, pelatihan inspeksi masih dengan cara yang konvensional, dan surveyor harus menyediakan waktu dan upaya mereka untuk pergi ke lokasi untuk melakukan inspeksi dan mengambil risiko atau dengan pembelajaran tatap muka. Mengingat tidak efisiennya dan apa yang dipertaruhkan, sangat penting untuk mencari inspektur yang andal. Menciptakan kompetensi dan keterampilan untuk inspektur profesional adalah kebutuhan akan banyak pengalaman dan pelatihan. Untuk melakukan pelatihan inspektur, diperlukan simulasi lingkungan berdasarkan kondisi apa yang perlu diperiksa. Mahal untuk membuat simulasi lingkungan dan alasan terbatasnya ruang dan waktu yang dihabiskan untuk melakukan pelatihan inspeksi bagi surveyor. Teknologi virtual realitas dapat menjadi solusi untuk masalah ini karena virtual realitas tidak berisiko dan tidak menghabiskan banyak biaya.

Penelitian ini akan dimulai dengan identifikasi masalah, pengumpulan data, tahap analisis, pembuatan objek virtual, dan Tahap Uji Coba. Penyerahan tesis ini akan menjadi aplikasi virtual realitas yang dapat dikendalikan dengan remot berdasarkan sistem operasi Android yang mana model dan sesainnya berdasarkan kapal container, MV. Meratus Benoa. Aplikasi ini dirancang dengan dua mode utama, yaitu mode tour kapal yang dapat membawa pengguna untuk menjelajahi lingkungan kapal dan melihat penjelasan peralatan pemadam kebakaran dan mode Inspeksi yang membawa pengguna untuk menyelesaikan misi 15 menit untuk menemukan semua peralatan pemadam kebakaran di seluruh kapal dan memenuhi daftar periksa inspeksi. Realitas Virtual bermanfaat untuk sektor apa pun karena dapat meningkatkan kompetensi, pengalaman, akses mudah, dan mudah digunakan. Berdasarkan tujuan dari aplikasi ini, dapat disimpulkan bahwa aplikasi ini dapat mengembangkan dan mensimulasikan inspeksi peralatan keselamatan kebakaran dengan membuat model kondisi nyata dari peralatan keselamatan kebakaran menjadi pemodelan 3D dan menginstal ke pembuat aplikasi realitas virtual. Dan berdasarkan hasil kuesioner pengguna, aplikasi ini masuk dalam kategori sangat baik karena nilai totalnya adalah 364 yaitu antara 360 dan 450 (maksimum), yang merupakan kategori sangat baik.

Kata Kunci: Virtual Realitas, Alat Pemadam Kebakaran, Perencanaan Kontrol Kebakaran, Training Inspektor, 3D modelling, Inspeksi

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CHAPTER 1
INTRODUCTION

1.1. Background

With the rapid advancement of technology today, it is possible to be implemented in the maritime industry. Moreover, in Indonesia, which incidentally is an archipelago where many islands are connected by the sea, which means that it has significant potential to develop technology in the maritime industry. The scope of the maritime industry in Indonesia is not only about ships but includes banks, insurance, shipyard industries, machinery industries, consultants, sports boating, cruise industry, trucking, shipping lines, bunkering services, logistics providers, port operators, agent/brokers, traders/cargo owners, custom, and classification society, marine education, and marine survey. That is means that there are still many opportunities in various fields to integrate industrial maritime with technology. All this business field has interconnection and has one of orientation to marine safety so that there is safety regulation to control and prevent from an accident.

Safety of a ship is a paramount concern, so that needs to do routine inspection and survey for every safety equipment to make sure the equipment can properly working when it is needed immediately. Safety on a ship includes fire fighting equipment and safety equipment, and another safety aspect. All ship should prove information about their safety that can be found in a Fire Control Plan that mandatory from SOLAS convention chapter II regulation 15. Fire Control Plan provides information about fire stations on each deck of the ship, on various bulkheads, and explains about the type of fire detection system and fire fighting systems available on the ship. To create an experience and maximise surveyor competencies, also emphasise to focus on a sure thing, and accessible learning in simple and effective ways, marine survey field has to implement Virtual Reality technology to create virtual survey training in anywhere and anytime.

Virtual reality is a technology that can mimic/visualise an environmental situation and involve the human senses using a computer system and emphasises the interaction between users and systems. Virtual reality can create an artificial environment that is created with software and presented to the user so that the user suspends belief it as a real environment, primarily experienced through two senses: sight and sound.

Virtual reality becomes a rapidly developing topic and can become a solution to support the maritime industry sector, such as in a marine survey, and inspection. The significant advantages of using virtual reality are simple and effective, do not need to spend a lot of effort and time, also less expense than real training methods. In this final project also has intended to keep up the educational world with modern information technology.

1.2. Research Problem

There is some problem occurs based on the background above, there is :

a. How to implementation virtual reality technology to develop fire safety equipment inspection.
b. How to model the real condition of the fire safety appliances into 3D modelling and install into a virtual reality application maker.
c. How to adjust the proportional dimension of fire safety appliances into virtual reality application make.
d. How to determine the compatibility of virtual reality applications with user devices.
e. How to adjust the user is dizzy feelings when using virtual reality applications due to dizzy.

1.3. Research Limitation

A limitation was made so that the study is not too broad to aspects that are not far from relevance so that research can be more focused to do; the limitation of this study is as follows:

a. The virtual reality system is only on fire safety equipment on every deck.
b. The fire safety equipment info is taken on MV. Meratus Benoa

1.4. Research Objective

The objective of this final project based on the problem occur are :

a. To implement virtual reality technology to develop and simulate fire safety appliances inspection
b. To model the real condition of the fire safety appliances into 3D modelling and install into a virtual reality application maker.
c. To adjust the proportional dimension of fire safety appliances into virtual reality application make.
d. To determine the compatibility of virtual reality applications with user devices.
e. To adjust the user dizzy feelings when using virtual reality applications due to dizzy.

1.5. Research Benefit

The desired benefit from the results of this final project is:

a. The virtual training software can increase the competence and quality of marine surveyor
b. Virtual training can reduce cost spending
c. Virtual Reality training can be applied for surveyors reality in anywhere and anytime

CHAPTER 2
LITERATURE STUDY

2.1. Problem Overview

Inspection of fire fighting equipment on board is vital, and the surveyor is responsible for that. in case of fire, the extinguishers must be able to work correctly, and the surveyor must ensure that they are working correctly and can be used without problems by the crew, and are not out of date. That is why professional surveyors are needed.

Creating competencies and skill for professional surveyors is need many experiences and training. To conduct training, an environmental simulation based on the conditions of what needs to be inspected is required. Expensive to make environmental simulations and reasons for limited space and time spent on conducting inspection training for surveyors. Virtual reality technology can be a solution to this problem because virtual reality does not make risky and takes many costs invested.

2.2. Fire Control Plan

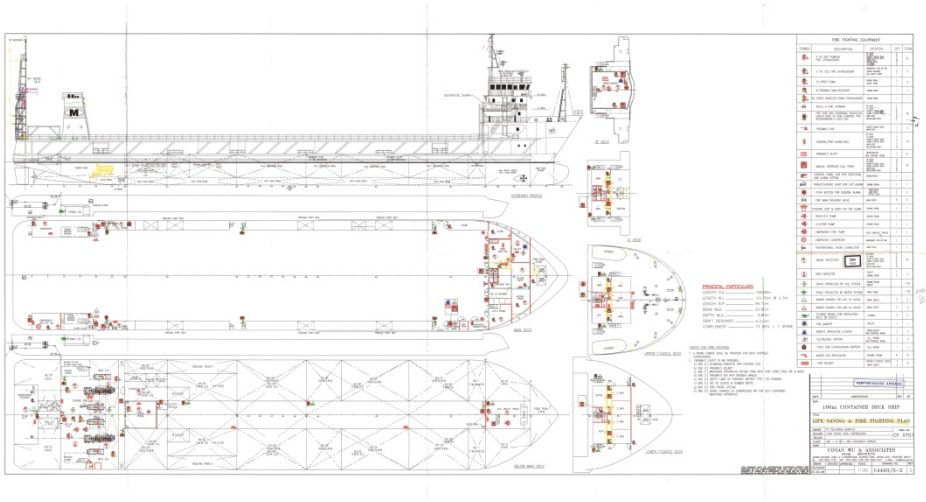


Figure 2.1 Fire Control Plan
Source: (ARS co. Ship Design & Consulting Company,2019)

2.2.1. Definition

The Fire Control Plan is a document on a ship that provides information regarding fire station and equipment location on each deck of the ship on various bulkheads, variety fire alarm system, sprinkler installation, extinguishing equipment, means of escape to different compartments and decks, and ventilation system including particulars of remote operation of dampers and fans. It also explains the type of fire detection system and fire fighting systems available on the

ship. Figures 2.1 is the example of Fire Control Plan of MV. Meratus Benoa Ship. The Fire control plan is not just a paper requirement for the classification society or the port state control, but all the ships crew must understand and know where the appliances located when needed. The Fire Control Plan one of the mandatory requirement of SOLAS convention, regulation 15 of Chapter II that requires general arrangement plans to be permanently exhibited for the guidance of the ship's officers. These plans are to show the structure fire prevention measures, the location of the firefighting equipment and the means of access to different compartments. Description in such plans shall be in the language or languages requires by the administration. If the language is neither English nor French, a translation into one of these languages shall be included. (SOLAS, 1974)

Fire safety appliances are the equipment that must provide on board as regulated in Chapter II-2 SOLAS which are then clarified in Fire Safety System Code (FSS Code) which it is international code for Fire Safety Systems.

2.2.2. Fire Control Plan Objective

The details of fire safety provisions for all ships and specific measures for passenger ships, cargo ships, and tankers are detailed below. (SOLAS, 1974)

a) Prevent the occurrence of fire and explosion,
b) Reduce the risk of losing life caused by fire,
c) Reduce the damage risk caused by fire to the cargo, the ship and the environment,
d) Containing, control and suppress fire and explosion in the compartment of origin,
e) Provide adequate and readily accessible means of escape for the crew.

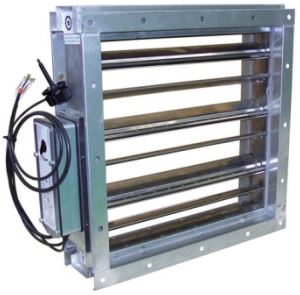
2.2.3. Fire Safety Equipment on Board

Table 2.1 List of Fire Equipment
Source: (SOLAS, 1974)

No	List Name	Picture
1	Fixed fire detection and alarm systems	 Figure 2.2 Fire Alarm *Source: (MediaExpert)*

2	Fixed gas and CO2 fire-extinguishing systems	 Figure 2.3 Fixed Gas Fire Extinguishing systems *Source: (MarineInsight, 2010)*
3	Fire doors	 Figure 2.4 Fire Door *Source : (nauticexpo, 2019)*
4	Wheeled (mobile) fire extinguishers	 Figure 2.5 Wheeled Extinguishers *Source: (Jiaxing Seaman Marine Co., 2009)*
5	Breathing apparatus	 Figure 2.6 Marine Breathing Apparatus *Source: (Jiaxing Rongsheng Lifesaving Equipment Co., 2012)*

6	Water mist, water spray and sprinkler systems	 Figure 2.7 Sprinkler *Source: (Alamy, 2019)*
7	Fire main, fire pump, hydrants, hoses and nozzles	 Figure 2.8 Emergency Fire Pump *Source: (U.S. Department of Labor)*  Figure 2.9 Hydrant, Hoses and Nozzle *Source: (Inc, 2019)*
8	Firefighter's outfits	 Figure 2.10 Firefighter outfit *Source: (MarineInsight, 2010)*
9	Fixed dry chemical powder systems	 Figure 2.11 Fixed dry chemical powder

		systems *Source: (Pro Tech Co.)*
10	Portable applicators	 Figure 2.12 Portable Fire Extinguisher *Source: (Rifqy, 2017)*
11	Ventilation systems and fire dampers	 Figure 2.13 Fire Dampers *Source: (Expo, 2019)*

2.2.4. Fire Safety Appliances Maintenance and Inspection

Fire-fighting system and appliances shall be kept in good working order and readily available for immediate use. Portable extinguishers which have been discharged shall be immediately recharged or replaced with an equivalent unit (SOLAS, 1974). Inspections, maintenance, and testing shall be carried out based on the guidelines developed by the IMO and in a manner having considered ensuring the reliability of fire-fighting appliances and the systems

2.3. Virtual Reality

The first fifteen years of the 21st century has been significant, rapid advancement in the development of VR. Computer technology, especially powerfull and small mobile technologies, have exploded while prices are always driven down. The rising of smartphones with high-density displays and 3D graphics capabilities has enabled a generation of lightweight and practical VR devices. Depth sensing cameras sensor suites, natural human interfaces and motion controllers, are already a part of daily human computing tasks. The game industry has continued to drive the development of consumer virtual reality.

2.3.1. History of Virtual Reality

2.3.1.1. Panoramic Painting

Figures 2.14 is the panoramic paintings from the nineteenth centuries. These paintings were intended to fulfil the viewer's entire field of vision, making them feel present at some historical event or scene and creating the illusions that we are present somewhere we are not.

Figure 2.14 Battle of Borodino
Source : (TheFreshUK, 2017)

2.3.1.2. 1838 -- Stereoscopic photo and viewer

In 1838 research of Charles Wheatstone explain that the brain processes the different two-dimensional images from each eye into a three dimensions object as the picture in figure 2.15. Viewing two sides by sides images through a stereoscope gave the user a sense of depth and immersion. (TheFreshUK, 2017)

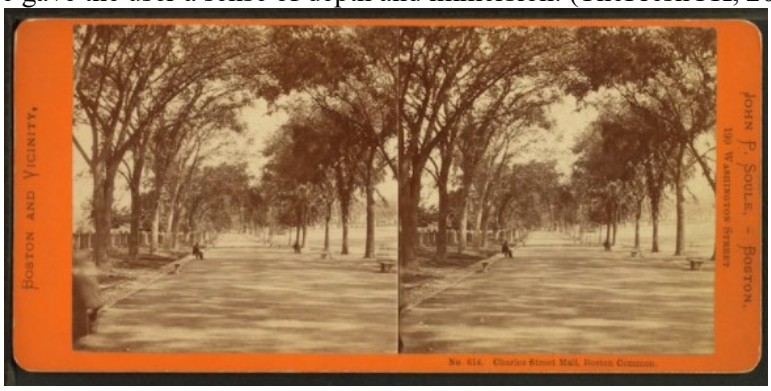


Figure 2.15 The Stereoscopic Photo
Source: (TheFreshUK, 2017)

2.3.1.3. 1929 –The First Flight Simulator

In 1929 Edward Link created the first example of a commercial flight simulator shown in figures 2.16. The simulator controlled by motors that linked to the rudder and steering to control and change the pitch & roll and a small motor-driven device simulates turbulence and disturbances. During World War II this flight simulator was used by over 500,000 pilots for initial training and improving

their skills. That was the need for safer ways to train pilots that the US military. (TheFreshUK, 2017)

Figure 2.16 The Link Trainer
Source : (TheFreshUK, 2017)

2.3.1.4. 1930 – Science fiction story predicted VR

Figure 2.17 Stanley G. Weinbaum
Source : (TheFreshUK, 2017)

In the 1930s a story of science fiction Pygmalion's Spectacles written by Stanley G. Weinbaum in figure 2.17, contains the idea of a pair of goggle that let the user experience fictional worlds through holographic, smell, taste, and touch. (TheFreshUK, 2017)

Figure 2.18 Pygmalion's Spectacles
Source: sffaudio (2017)

2.3.1.5. 1950 – Morton Heilig's Sensorama

In the mid-1950s cinematographer, Morton Heilig developed and created the Sensorama as shown as figure 2.19 below, which was an arcade-style theatre that will stimulate all the senses, not just sound, and sight. It adds some featured like smell generators, stereo speakers, a stereoscopic 3D display, fans, and a vibrating chair. The Sensorama is intended to immerse the user in the film entirely. (TheFreshUK, 2017)

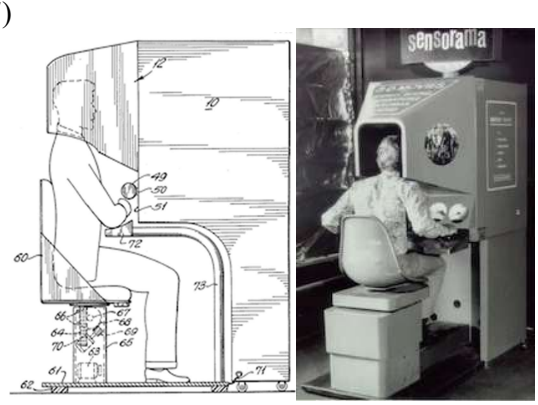


Figure 2.19 Morton Heilig's Sensorama
Source: Morton Heilig(2017)

2.3.1.6. 1960 – The first Head-Mounted VR

Figure 2.20 is Morton Heilig's next finding innovation was the Telesphere Mask, and was the first example of a head-mounted display (HMD), although it is for the non-interactive film medium without any motion tracking. The headset provided stereoscopic 3D and full vision with stereo sound. (TheFreshUK, 2017)

Figure 2.20 Head-Mounted Display
Source : (TheFreshUK, 2017)

2.3.1.7. 1968 – Sword of Damocles by Ivan Sutherland

In 1968 Bob Sproull and his teacher Ivan Sutherland created Sword of Damocles as shown in figure 2.12 below, the first VR / AR Head-Mounted Display

that was connected to a computer, and not a camera. This discovery was significant, and that was too heavy for any user to wear and was suspended from the ceiling comfortably. The wearer would also need to be strapped into the device. The computer-generated graphics were very primitive, wireframe rooms and objects.

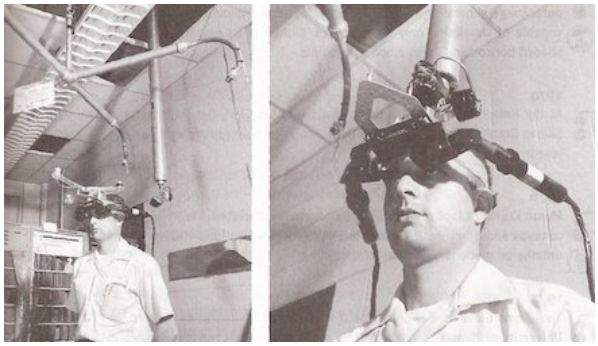


Figure 2.21 Sword of Damocles
Source : (TheFreshUK, 2017)

2.3.1.8. 1987 – Virtual reality the name born

Jaron Lanier in 1987, the founder of the Visual Programming Lab (VPL), coined the term "virtual reality." The research area now had a name; after all of this development in virtual reality, there still was not an all-encompassing term to describe the field. They are the first company to sell Virtual Reality goggles, as shown in figure 2.22, and the price is around $9400 - $49,000 at that time and gloves around $9000. A significant development in the area of virtual reality haptics.

Figure 2.22 Virtual Reality goggles and gloves
Source : (TheFreshUK, 2017)

2.3.1.9. 1991 – Virtuality Group Game Machines

The Virtuality Group launched games machines, as shown in figure 2.23. Players would wear a set of Virtual Reality goggles and play on gaming machines with realtime with immersive stereoscopic 3D visuals. Some units were also linked together for a multi-player gaming experience.

Figure 2.23 Gaming Machine
Source : (TheFreshUK, 2017)

2.3.1.10. 1993 New VR glasses by SEGA

Sega announced the VR headset for the Sega Genesis console in 1993 at the Consumer Electronics Show in 1993. The wrap-around prototype glasses had head tracking, stereo sound and LCD screens in the visor, as shown in figure 2.24. However, technical development difficulties meant that the device would forever remain in the prototype phase despite having developed four games for this product. This was a massive flop for Sega. (TheFreshUK, 2017)

Figure 2.24 Sega Genesis console
Source : (TheFreshUK, 2017)

2.3.1.11. 1995 – Nintendo Virtual Boy

The Nintendo Virtual Boy was a 3D gaming console that was hyped to be the first-ever portable console that could display beautiful 3D graphics, as shown in figure 2.25. It was a failure despite price drops for the first time released in japan in America for $180. The reported reasons for this failure is a lack of software support, there was a lack of colour in graphics, and it was difficult to use the console in a comfortable position. The following year they discontinued its production and sale. (TheFreshUK, 2017)

Figure 2.25 Nintendo Virtual Boy
Source : (TheFreshUK, 2017)

2.3.1.12. Virtual reality in the 21st century

It seems that 2016 will be a pivotal year in the VR industry. Many inventions for consumer devices that seem to finally answer the unfulfilled needs made by VR in the 1990s that come to market at that time. Developer versions of final consumer products have also been available for a few years, so there has been a steady stream of software projects creating content for the imminent market entrance of modern virtual reality (Tumey, 2018). Recently companies like Google have already released virtual reality products such as Google Cardboard, a headset that uses a smartphone to drive it. Other companies like Samsung have taken this concept further with products such as the Galaxy Gear, which is mass-produced and contains “smart” features such as gesture control.

2.3.2. Working Principle of VR

The Virtual Reality idea is to deliver a sense of being there, at least giving the eye what it would have received, and to have the image change instantly as the point of view is changed (Smith, et al., 2004). The factor about the perception of reality feel is driven by various visual cues, brightness, like relative size, and angular movement. One of the strongest and powerful is perspective; for example, binocular form in that the right and left eyes see different images then fusing these images into one 3D perception is the basis of stereovision. (Onyesolu, et al., 2011)

The basic perception of depth provided by each eye seeing a slightly different image is most useful for objects very near the user. Objects farther away mostly cast the same image on each eye. Virtual Reality was synonymous with glasses that provide a display for each eye. Each display delivers a different perspective picture of what the user sees. As the user moves head with googles, the picture rapidly changes and updates, so that the user feels like they are the cause of these changes by moving the head and the computer following the user movement. (Onyesolu, et al., 2011) You feel you are the cause, not the effect.

2.3.3. Virtual Reality Components

The components necessary for building VR are divided into the hardware components and the software components.

2.3.3.1. Hardware Components

Table 2.2 Hardware Component

No	Name	Description	Picture
1	Head-Mounted Displays	Head-mounted displays place a screen in front of each of the viewer's eyes at all times	 Figure 2.26 VR Glasses
2	Input Device	Function to interact with the virtual environment and objects within the virtual environment. Such as like joystick, instrumented glove, keyboard, and voice recognition.	 Figure 2.27 Remote VR
3	Smartphone	As a device to run the virtual reality application, with a specification of the Android operating system and minimum ram is 4 GB.	 Figure 2.28 SmartPhone

2.3.3.2. Software Component

The software components are divided into some components that are, 3D modelling software, digital sound editing software, and Virtual Reality simulation software.

Table 2.3Software Component

No	Software	Description
2	3D Modeling	It has a function to specifies the visual properties of these objects and constructing the geometry of the objects in a virtual world. For example is a blender, 3DS Max, Autocad 3D.
3	Digital Sound Editing	Digital sound editing software is a function to mix and edit sound that objects make within the virtual environment
4	VR Simulation	It is used to set the rules that the virtual world follows and program how these objects behave. In this thesis is using the Unity application.

2.3.4. Application of VR and Related Research

Virtual Reality is being applied in all areas of social business, and many VR applications have been developed for training in a variety of areas like military, medical, equipment operation. Also in manufacturing, education, simulation, design evaluation (virtual prototyping), simulation of assembly sequences, architectural walk-through, ergonomic studies, and maintenance tasks, assistance for disabling, study and treatment of phobias like fear of height, entertainment, rapid prototyping and much more.

2.3.4.1. Life-Saving Appliances Inspection Training Using VR Application

Rafiqi Zulfauzi. S. T has researched the development of Life Safety Appliances training inspections using virtual reality applications on container type vessels, namely MV. Meratus Bontang, but the scope and limits studied were only for navigation decks, B decks, and Upper forecastle decks. In this follow-up research, the development of fire safety equipment inspection using virtual reality will be carried out. In the maritime sector or out of the maritime sector, virtual reality can answer and illustrate the specified challenges and solution.

2.3.4.2. Virtual Wind Park

To illustrate to the city about future installation by virtual product. For example, in figure 2.29 below is an example of virtual wind - park installation at the Baltic Sea, this marketing using virtual reality to inform and to make the public know.

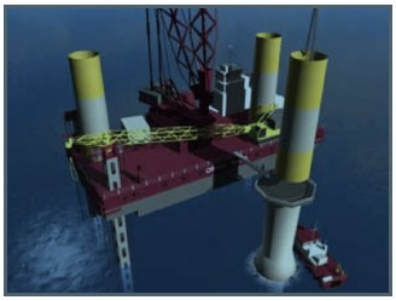


Figure 2.29 VR visualisation in offshore.
Source: Virtual and augmented reality for the maritime sector – applications and requirements (2010)

2.3.4.3. Design Review

In Germany, many shipyards are in the process of integrating with virtual reality to their standards procedure of the design. They are a focus on using VR as a tool for review where stakeholder discusses several aspects, and this supported by the national German Research Project, like in figure 2.30.

Figure 2.30 VR review at IGD's Maritime Graphics lab in Rostock.
Source: Virtual and augmented reality for the maritime sector – applications and requirements (2010)

2.3.4.4. Game-Based for Maritime Security Training

The game engines combine handling and rendering of 3D objects with an efficient way to describe interaction and behaviour. A dangerous game approach introduces new media in the training of ship crews for virtual fire fighting accident, as shown in figure 2.31.

Figure 2.31 Fire Fighting Simulating.
Source: Virtual and augmented reality for the maritime sector – applications and requirements (2010)

2.3.4.5. Simulation Training for Operator

Virtual Reality can offer extremely efficient and cheap for practising and training of handling object or vessel for the operator. For example, in figure 2.32, in this figure below show a new underwater vessel, that complex for operation, so that virtual training is the best solution.

Figure 2.32 Simulator for an underwater vessel.
Source: University of Girona

2.3.4.6. Maintenance Support

Figure 2.33 describes that is combining real object and digital content, using a combination of VR and AR, by mixing computer-generated content with a live video stream of a scene. That can be helpful and useful to support a ship crew that has limited resources and competencies. In this system will present the repair procedure of a pump or filter.

Figure 2.33 Adjustment of a ship engine governor with AR.
Source: Virtual and augmented reality for the maritime sector – applications and requirements (2010)

2.3.4.7. BMW Research For Verifying Product Design Using VR

In 1999, BMW company had researched the Virtual Reality capability for verifying product designs (Gomes de Sa, et al., 1999). So it is proven to be a useful tool for workers evaluates product design. They are stated that Virtual Reality has the significant potential to diminish the number of physical prototypes needed to improve overall product quality and to obtain quick answers intuitively during the concept phase of a product.

2.3.4.8. Motorola VR Research for training to run a pager assembly line

Motorola developed a virtual reality technology for training workers to run a pager assembly line (Wittenberg, 1995). They found that virtual reality can be used to train manufacturing personnel successfully and that participants trained in virtual reality environments perform better on the job than those trained for the same time in real environments.

2.3.4.9. GE Corporate Research To Develop VR Application

In 1998, GE Corporate Research developed virtual reality software applications, which allowed engineers to interactively fly through a virtual jet engine (Abshire, et al., 1998). They reported that the applications were used successfully to enhance design communication and to solve maintenance problems early, with the benefit of minimal cost, delays, and effort. They also reported that using virtual reality applications helped make maintenance an integral part of their product design process. The success stories from industry show that virtual reality technology-literate professionals are a present and future industry need.

2.3.4.10. Boeing Research for Virtual Space eXperiment (VSX)

Boeing is the largest aircraft manufacturers in the world developed the Virtual Space eXperiment. Virtual Space eXperiment is a demonstration of how the design of aircraft and other complex systems involving interactions of human interaction (Kalawsky, 1993). It is a three dimensional virtual model of the interior and

exterior of a tilt-rotor aircraft in a virtual world that allows persons to interact with various items such as maintenance hatch, cargo ramp.

Moreover, McDonnell Douglas uses a system to evaluate how a virtual environment can aid the design of a new engine type. The system is utilised to explore the process of installing and removing the engine, especially for detecting the potential interface with other devices.

2.3.4.11. Virtual Reality Technology To Design And Build A Cars

The automotive industry starts to use virtual reality technology to design and concept, build cars. It can take two years or more to advance from the development of an initial concept for a new type of car to the moment that a production version rolls off the assembly line. The engineering team developed a virtual reality system for evaluating process installation feasibility in automotive assembly. (Shin)

2.3.4.12. Virtual Reality For Education

Mathematics and science teachers have used VR for explaining abstract spatial data. Virtual Reality is a powerful tool for education since people comprehend images much faster than they grasp lines of text or columns of numbers. Virtual reality offers immersive multisensory environments that engage students and allow them to visualise information . (Bricken, et al., 1992) used VR to help students learn elementary algebra. They used three-dimensional space to express algebraic concepts and to interact with spatial representations in a virtual environment. They concluded that VR has the potential for making a significant improvement in the way students learn mathematics. Then (Haufmann, 2000) used Virtual Reality in mathematics and geometry education, especially in vector analysis and descriptive geometry. Their survey showed that all participants of a total of 10 students rated VR as a perfect playground for experiments, and all participants wanted to experience Virtual Reality again. Students also thought it was easier to view a 3D world in VR rather than on a flat-screen.

2.3.4.13. Virtual Reality In The Field of Architects

In Japan, customers bring the architectural layout of their home kitchen to the Matsushita store and plug it into the computer system to generate its virtual copy. They can install appliances and cabinets, and change colours and sizes to see what their complete kitchen will look like without ever installing a single item in the actual location. Similarly, Mike Rosen and Associates has been using an interactive and immersive VR technology to assist its building industry clients in the design, visualisation, marketing, and sales (Neil, 1996).

2.3.5. Advantages of Virtual Reality

Virtual reality technology has great value in situations where exploration of environments or interactions with objects or people is inconvenient or impossible,

or where an environment can only exist in computer-generated form. Virtual Reality application for inspection training is less-expenses and have to go to the real condition. Virtual training can be access in anytime and anywhere.

2.4. Expected Result

The result of this thesis will be in the form of android application as figure 2.34. The developments from previous research that conduct by (Rafiqi, 2019), are expected to be applicated on inspection for surveyor training and educational purpose. Also expected to be used for familiarisation for a new crew in the new ship that the new crew of the ship will be working on due to the rotational shift.

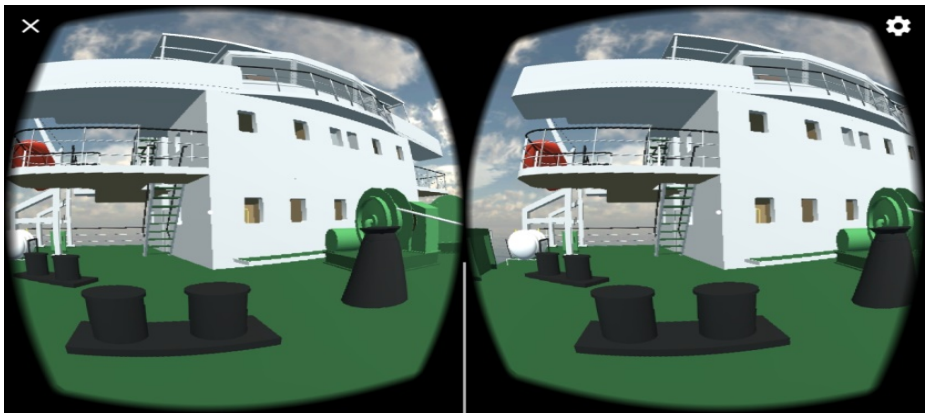
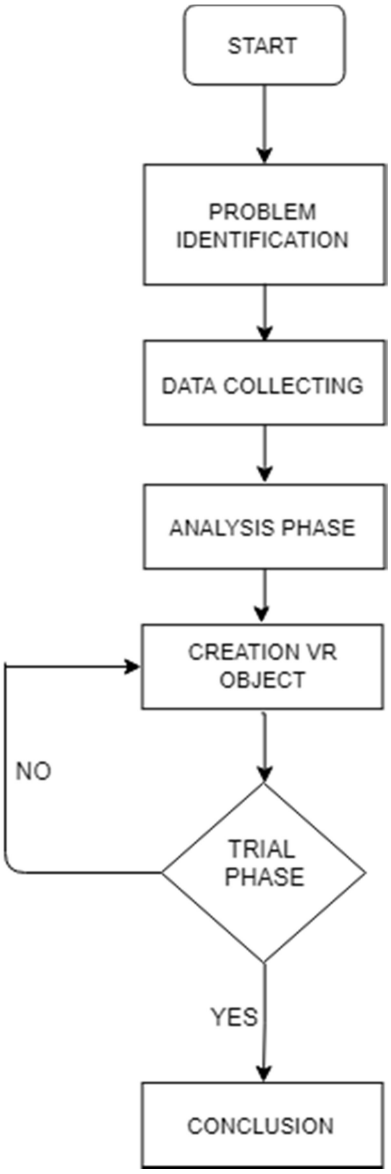


Figure 2.34 Outside View
Source: (Rafiqi, 2019)

CHAPTER 3
METHODOLOGY



3.1. Problem Identification

Nowadays, inspection training for surveyor to do fire fighting appliances inspection in the ship is still in a conventional way, and the inspector should provide their time and effort to go on-site to conduct an inspection and take a risk or by face to face learning. Considering the not efficient and what is at stake, it is crucial to seek a reliable inspector. Creating competencies and skill for the professional inspector is need many experiences and training. For Conducting inspector training, an environmental simulation based on the conditions of what needs to be inspected is required. Expensive to make environmental simulations and reasons for limited space and time spent on conducting inspection training for surveyors. Virtual reality technology can be a solution to this problem because virtual reality does not become risky and do not takes many costs invested and give the surveyors a different experience. Some aspect is needed to identify for creating the virtual reality application for training inspection, such as :

a. Modelling the actual condition of the fire safety appliances to the 3D Object.
b. Converting the 3D model of fire safety appliances to the virtual reality application
c. Determining the device specifications for compatibility of virtual reality applications.

3.2. Data Collecting

To obtain the data by directly go to the field for fire safety equipment survey to determine precisely task of a surveyor when checking the equipment. The data that should be collected is :

a. List of fire safety equipment that should be checked on board
b. Parameter indicator to determine whether the equipment is worth to use or not.
c. The task of surveyors on board
d. General Arrangement & Fire Control Plan of the ship
e. Dimensions of every equipment on fire safety appliances
f. Certificate of fire safety appliances

3.3. Analysis Phase

Analyse phase is to defining every equipment that needs to build in virtual reality application such as the proportional dimension and location and make as same as onboard based on drawing on fire control plan, and analysis every possible scenario that may be happening in real condition and faced by surveyors on the virtual reality application. The input of this phase is the data from the surveyor and actual condition of the appliances and become the list of scenario that will appear in the virtual reality application.

3.4. Creating VR Object

Creating and design virtual obstacle as the same close as possible to the real object using an application to create a 3D object and become an input to the virtual

reality application maker. This process must be done with care and focused because minor faults in this phase will steer the direction of progress and inaccuracy will cause repetition in this phase.

3.5. Trial Phase

In this stage will be thoroughly tested for the virtual reality program that has been made in android platform base by ten respond with different specification of their device due to the compatibility. The purposes of this phase are to make sure the application is working correctly without no error and bug, also confirm that it is progressing by requirements. In the trial phase will be done by giving a try of 10 respondent and evaluate their advice comment. If it passes in this trial phase, it will be finished, and the conclusion can be made, and if it does not pass or there is an error or bug, it will analyse why the error happens and back to creation Virtual Reality object or the step before. Furthermore, there will be an assessment using a questionnaire form to the user / respondent.

3.6. Conclusion

Conclusion stage is the last stage of this research, and after the virtual reality application has been successfully worked and get a review of the minimum ten responded.

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CHAPTER 4
DATA ANALYSIS AND RESULT

4.1. Research Object

Due to the availability of PT. Meratus Line Company to be surveyed in Surabaya, MV. Meratus Benoa is chosen to be an object target for being a model in virtual reality application.

Figure 4.1 MV. Meratus Benoa
Source: By Author (2019)

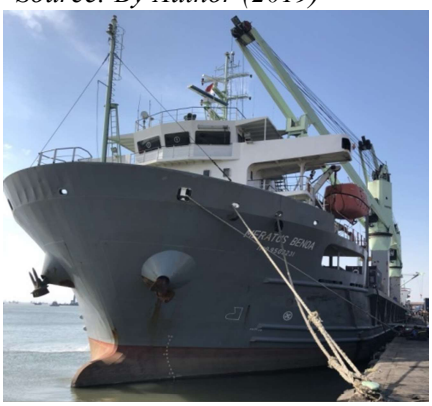


Figure 4.2 MV. Meratus Benoa
Source: By Author (2019)

4.2. Data Collection

The data and material to build the fire control plan virtual reality application consist of :

1. General Info of the ship MV. Meratus Benoa
   General info is used to know the dimensions of the ship for 3D modelling in virtual reality application, so the dimension is on a comparable scale.
2. General Arrangement of the ship MV. Meratus Benoa
   GA is used as a basis of room design and location of its room
3. Fire Control plan of MV. Meratus Benoa
   Fire Control Plan is used as a guided to the placement and to list and define every object of fire fighting equipment
4. Visual data
   Photos and videos on the actual condition based on a survey that has been conducted.

4.2.1. Ship Data General Info

This data below is used to know the size to determine the proportional scale and as additional information in the application.

Table 4.1 General Info of MV.Meratus Benoa

General Info	
IMO	9509231
MMSI	525025061
Call Sign	PNPC
Flag	Indonesia
Vessel Type	Cargo
Gross Tonnage	3668 T
Deadweight	5107 t
Length Overall x Breath Extreme	106,68m x 20,6m
Draught	4,215 m
Built	Indonesia
Home Port	Surabaya

4.2.1.1. Equipment List

To determine the list and location of fire fighting equipment, fire plan as shown in figure 4.3 can be a reference, but with the validation in the actual condition, and precision location of each equipment.

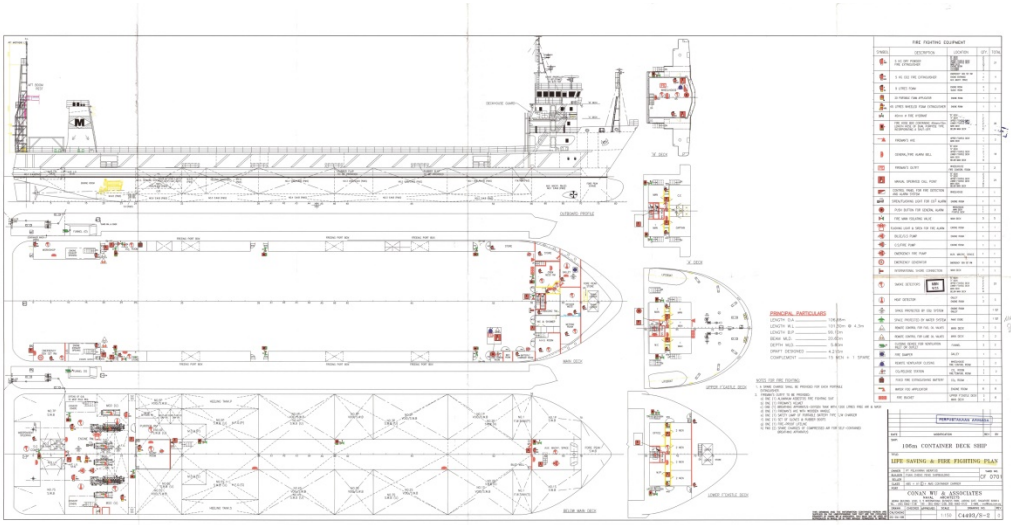
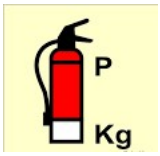


Figure 4.3 Redrawed of MV.Meratus Benoa Fire Control Plan
Source: PT.Meratus Benoa Company

Table 4.2 Fire Safety Equipment List

SYMBOL	DESCRIPTION	LOCATION	QTY
	5 KG DRY POWDER FIRE EXTINGUISHER	NAV DECK – wheelhouse "A" DECK – deckhouse UPPER F'CASTLE – deckhouse LOWER F'CASTLE – deckhouse LOWER F'CASTLE – store MAIN DECK – forepeak store MAIN DECK – deckhouse MAIN DECK – battery room MAIN DECK – store MAIN DECK – Emg. Genset Rm MAIN DECK – paint store ENGINE ROOM STEERING GEAR ROOM ENGINE ROOM	2 2 2 2 2 1 8 1 1 1 1 2 1 2
	40 mm ø FIRE HYDRANT	NAV DECK – open deck "A" DECK – open deck UPPER F'CASTLE - open deck LOWER F'CASTLE - open deck	1 2 2 2
	FIRE HOSE BOX CONTAINING 40 mm x 15 m.	MAIN DECK – cargo deck BELOW CARGO DECK STEERING GEAR ENGINE ROOM BOW THRUSTER RM	7 2 1 2 1

	GENERAL/FIRE ALARM BELL	NAV DECK – wheelhouse "A" DECK – deckhouse UPPER F'CASTLE – deck house LOWER F'CASTLE – deckhouse MAIN DECK – deckhouse MAIN DECK – workshop MAIN DECK – Emg Genset rm MAIN DECK – paint store BELOW MAIN DECK BELOW MAINDECK – ECR BELOW MAINDECK – E/R Steering Gear Room	1 1 2 1 4 1 1 1 3 1 1 1
	FIREMAN'S AXE	UPPER F'CASTLE – open deck MAIN DECK – cargo deck	1 1
	FIREMAN'S OUTFIT	NAVDECK - wheelhouse Engine Control Room	1 1
	MANUAL OPERATED CALL POINT	NAVDECK – wheelhouse "A" DECK – deckhouse UPPER F'CASTLE – deckhouse LOWER F'CASTLE – deckhouse MAIN DECK – deckhouse MAIN DECK – cargo deck MAIN DECK – Fire Control Rm BELOW MAIN DECK	2 3 3 3 1 5 1
	CONTROL PANEL FOR FIRE DETECTION & ALARM SYSTEM	WHEELHOUSE	1
	PUSH BUTTON FOR GENERAL ALARM	NAV DECK – wheelhouse MAIN DECK – fire control rm UPPER F'CASTLE – deckhouse	1 1 1

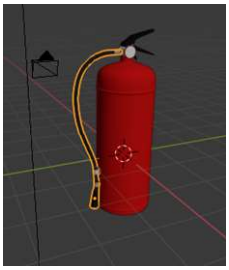
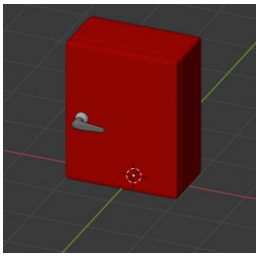
	REMOTE VENTILATOR CLOSING	NAVDECK - wheelhouse MAIN DECK - fire control room	1 1
	REMOTE CONTROL FOR FUEL OIL VALVES	MAINDECK – cargo deck	3
	REMOTE CONTROLS FOR LUBE OIL VALVES	MAINDECK – cargo deck	2
	SMOKE DETECTOR	NAVDECK – wheelhouse "A" DECK – deckhouse UPPER F'CASTL – deckhouse LOWER F'CASTLE – deckhouse MAIN DECK – deck house MAIN DECK – CO2 rm MAIN DECK – workshop MAIN DECK – Emg Genset rm MAIN DECK – paint store BELOW MAINDECK – E/R BELOW MAINDECK – ECR BELOW MAINDECK – purifier BELOW MAINDECK – SG rm BELOW MAINDECK – bowthrs	2 2 2 2 5 1 1 1 1 2 1 1 1 1
	HEAT DETECTOR	GALLEY ENGINE ROOM	1 2
	FIRE CONTROL PLAN (OUT DECK MUST BE IN STEEL BUCKET)	NAVDECK DECK "A" DECK UPPER F'CASTLE DECK LOWER F'CASTLE DECK MAIN DECK BELOW MAIN DECK	1 1 1 3 1 8
	FIRE DAMPER	GALLEY	1

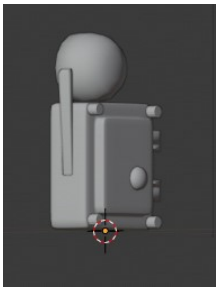
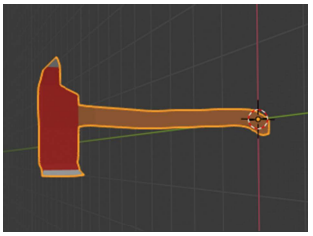
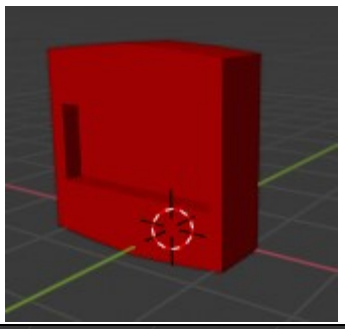
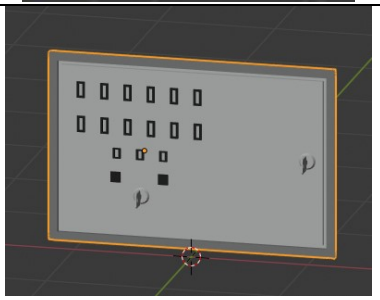
4.3. Create 3D Modelling

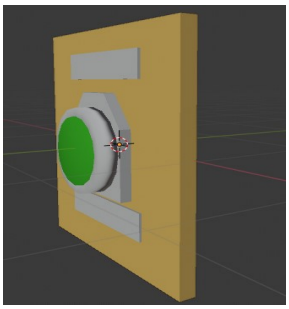
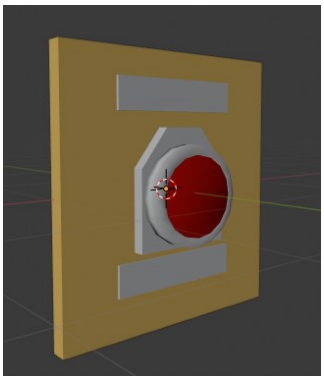
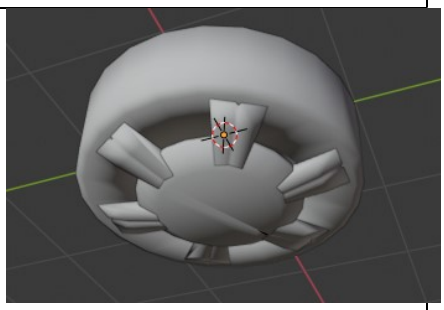
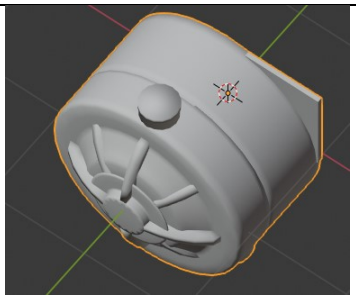
In this phase consists of creating the assets of the virtual environment using Blender application. The 3D models are drawn in Blender, which is a free and open-source 3D computer graphics software used for creating 3D models, visual effects, 3D interactive application, etc. The model is finalised to be as close as the actual object. The requirements for some assets can be precise from earlier phases of the analyses or even from the scenario draft. There are two main 3D models, such as ship deck with all the environment and fire fighting equipment 3d model.

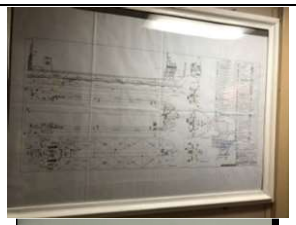
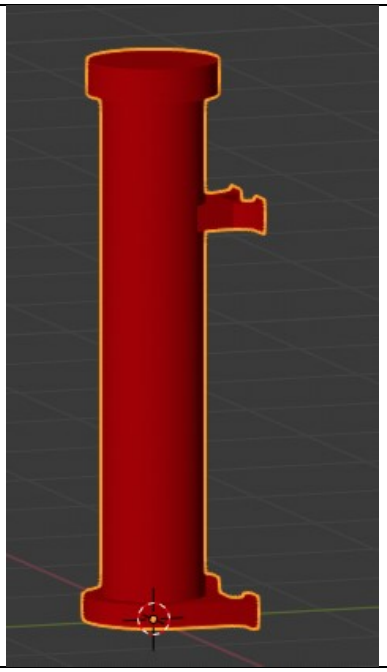
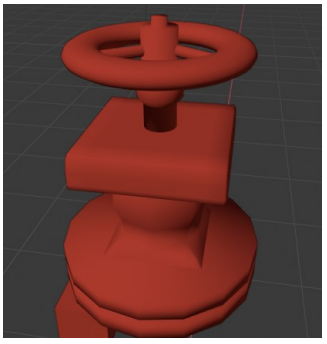
4.3.1. Fire Fighting Equipment Model

Table 4.3 Fire Safety Equipment 3D Model
Source: By Author

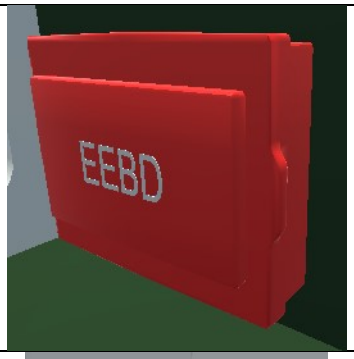
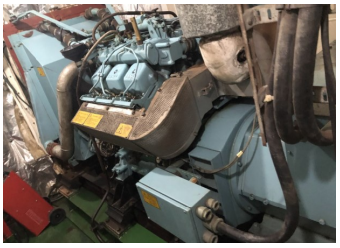
Description	Actual Model	3D Model
5 Kg Dry Powder Fire Extinguisher		
40 mm Ø Fire Hydrant		
Fire Hose Box Containing 40 Mm X 15 M.		

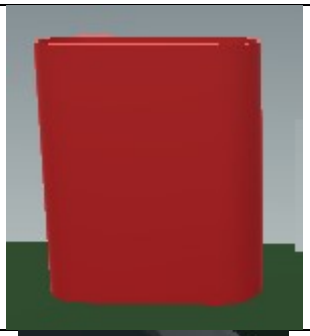
General/Fire Alarm Bell		
Fireman's Axe		
Manual operated call point		
Control panel for fire detection & alarm system		

Push button for general alarm		
Remote Ventilator Closing		
Smoke detector		
Heat detector		

Fire control plan (out deck must be in steel bucket)	 	
Fire Main Isolating Valve		

CO2 Alarm		
Fire Pump		
CO2 Release Station		

EEBD		
Emergency Generator		
Fireman Outfit		
International Shore Connection		

Portable Foam Applicator		
Water Fog Applicator		
Wheeled Foam Extinguisher		

4.3.2. Ship Deck Model

All the ship should convert into a 3D model which is Navigation Deck or B deck, A-deck, Upper Forecastle deck, Lower Forecastle deck, Maindeck, Engine Room, Engine Control Room, Corridor below the main deck, Bow Thruster Room. The 3D model is using Blender Application. The finished 3D Model will be added to the Unity, which is also a free and open-source cross-platform game engine

software. The independent objects that have been made in Blender such as the ship decks and fire-fighting equipment are put together.

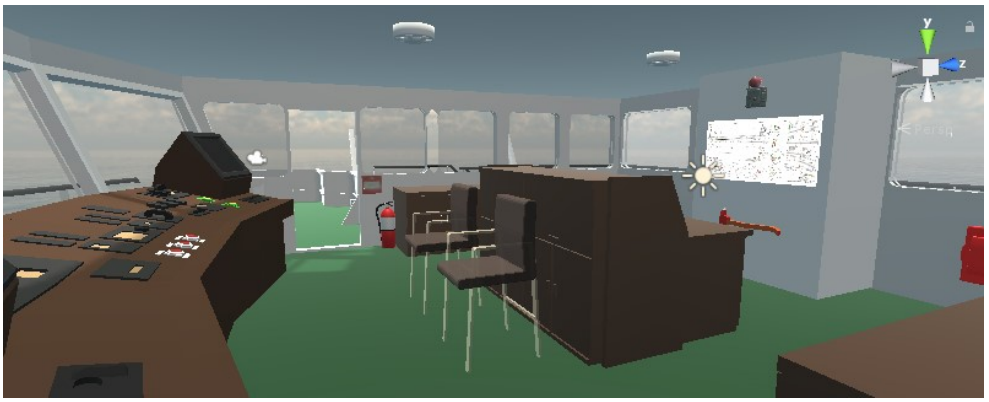


Figure 4.4 Wheelhouse
Source: By Author

Figure 4.5 Corridor Below Maindeck
Source: By Author

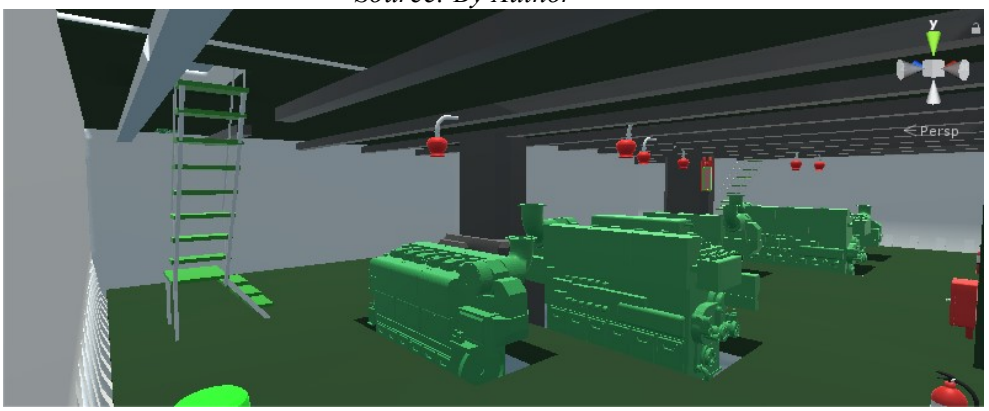


Figure 4.6 Engine Room
Source: By Author

Figure 4.7 Engine Control Room
Source: By Author

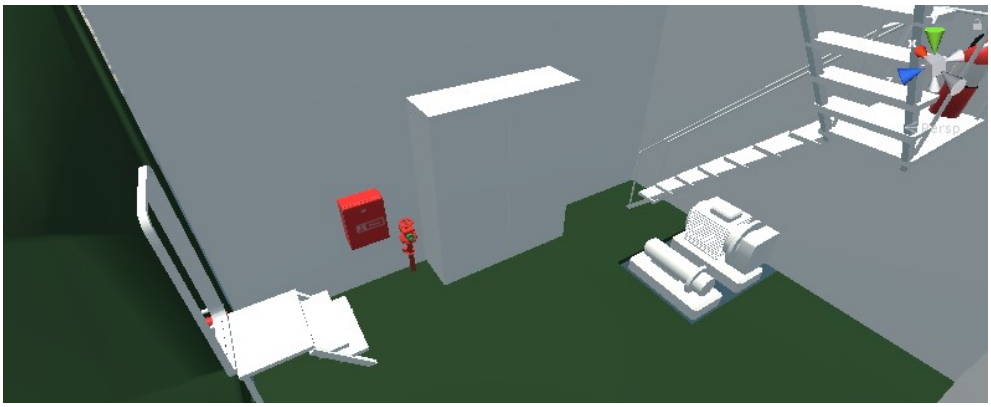


Figure 4.8 Bow Thruster Room
Source: By Author

4.4. User Interface

The user interface is a visual part of virtual reality application that ensures how a user interacts with the VR application and how information is displayed on the screen, in the other ways is a communication mechanism between user and the application system.

The design of the user interface is indeed fundamental because it will determine how a person interacts with the application.

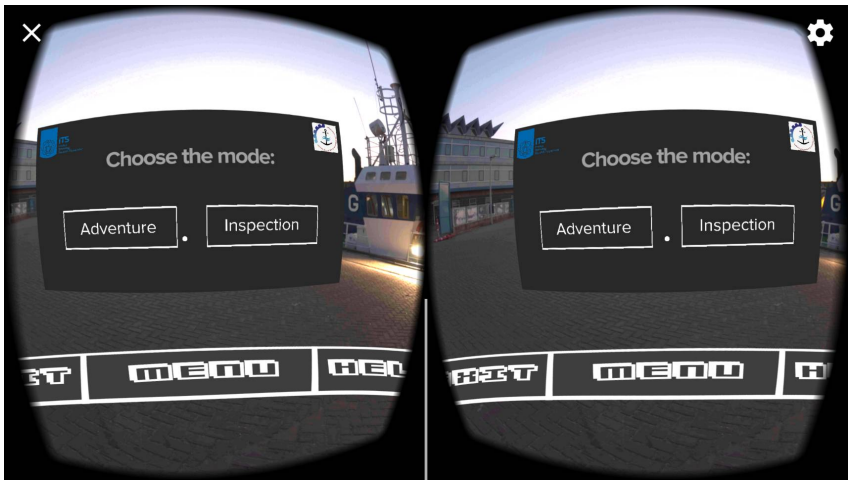


Figure 4.9 Main Menu User Interface
Source: By Author

Figure 4.9 showing the user interface of the main menu in the application with consist of option such as “Ship Tour”, “Inspection”, “Exit”, “Play”, “Help”. The white dot in the middle of the screen is the cursor for a choice menu in the application, and the user must be given the direction to the dot by moving the head-mounted VR glass to the menu until the dot change to white circle (shown in figure 4.11), and push the remote button to action. The remote button function is guided in the “Help” menu, as shown in figure 4.10. After the user chose the menu, there will be a loading sign on the screen, as shown in figure 4.13. “Exit” menu is to close the application.

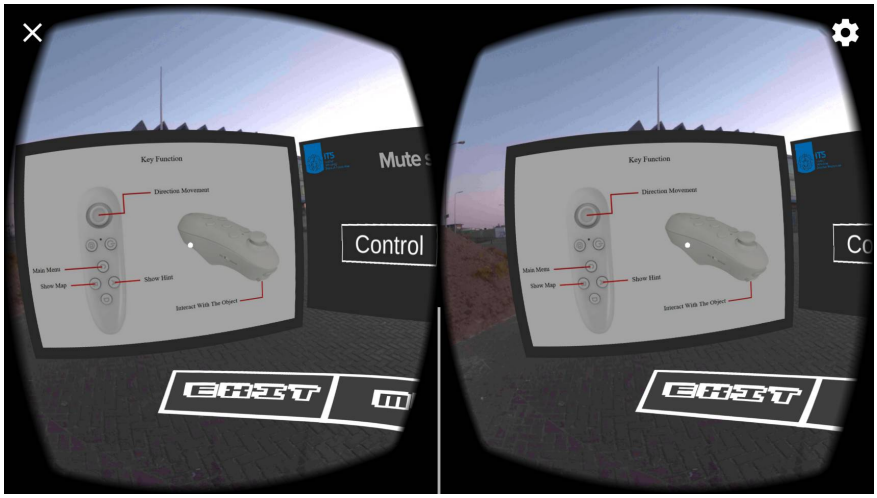


Figure 4.10 “Help” Menu User Interface
Source: By Author

Figure 4.11 “Inspection” Mode User Interface
Source: By Author

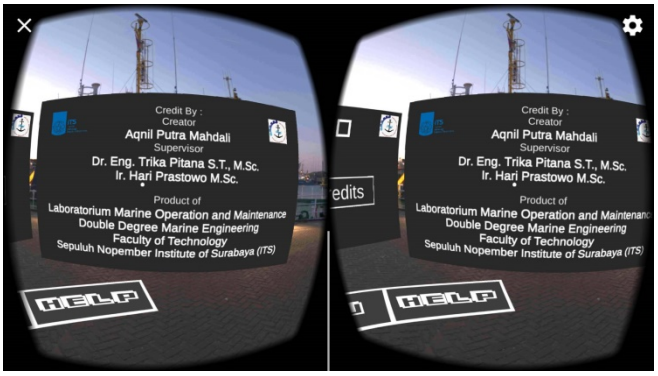


Figure 4.12 Credit Application
Source: By Author

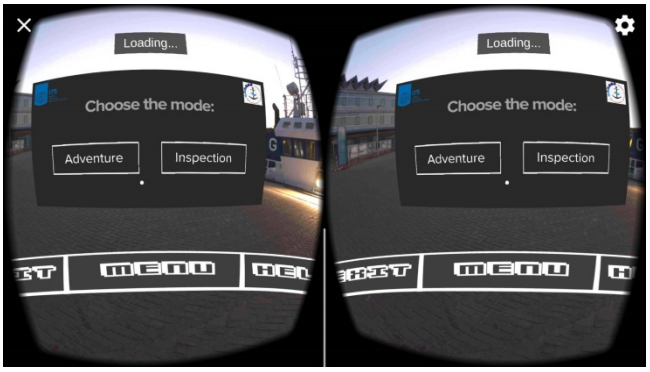


Figure 4.13 Loading Screen
Source: By Author

4.5. Mode and Features

The mode is made to deliver and describe the value of education in the virtual reality application. There will be two scenario mode in this virtual reality application which is Ship Tour mode and Inspection mode.

4.5.1. Ship Tour Mode

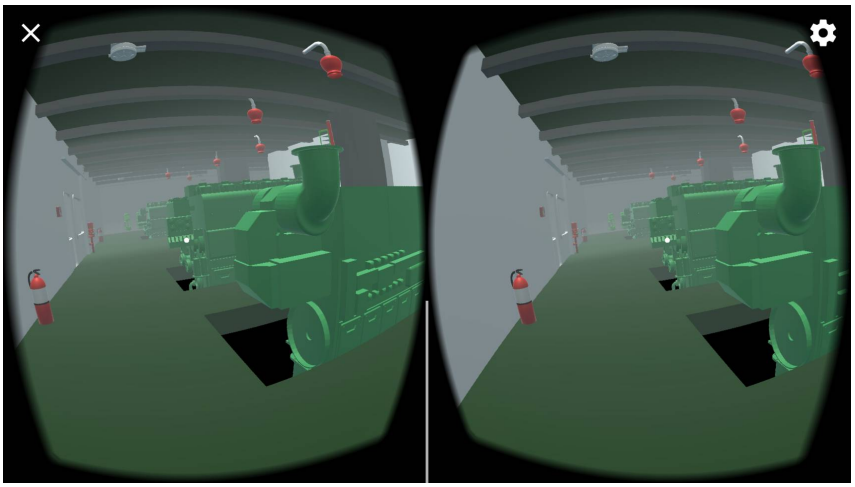
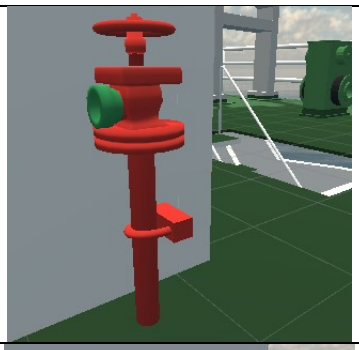
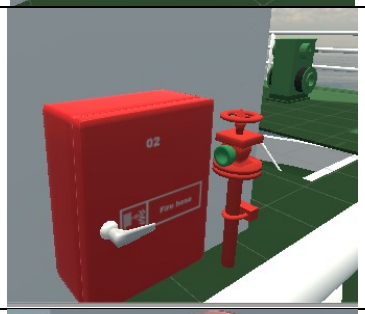
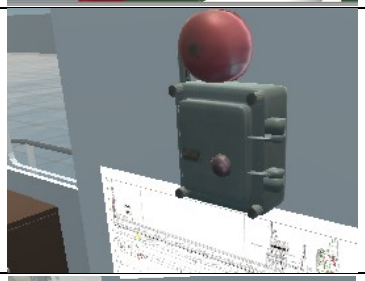
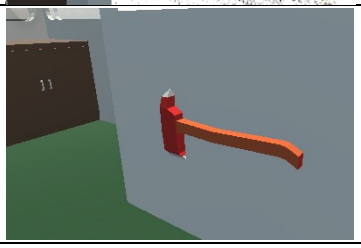


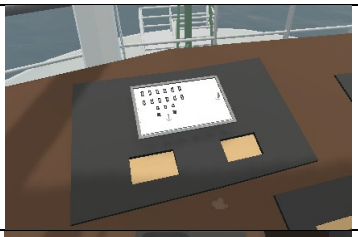
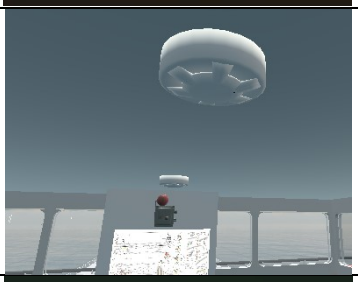
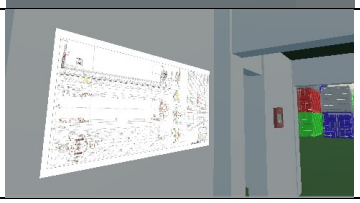
Figure 4.14 Explore Engine Room Condition
Source: By Author

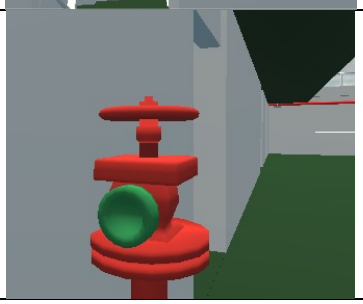
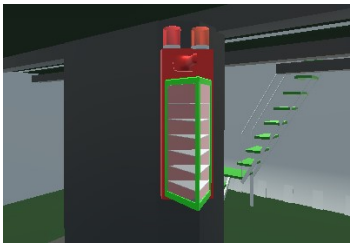
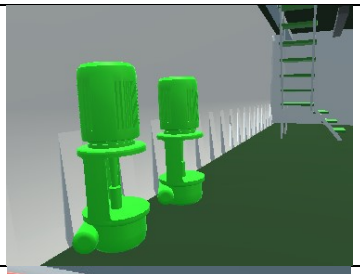
In this mode has an intention to give an introduction to the ship in the virtual world so that, the user can be free to explore the entire deck and ship environment. Ship Tour mode also has a feature of interaction in every fire fighting equipment, will appear an explanation of each equipment like in table 4.6.

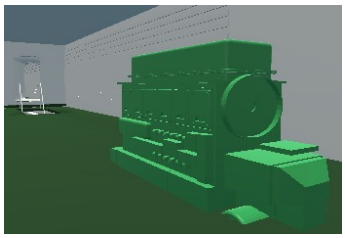
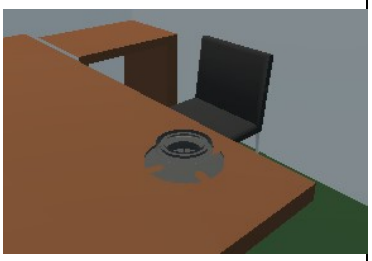
Table 4.4 Explanation equipment in ship tour mode

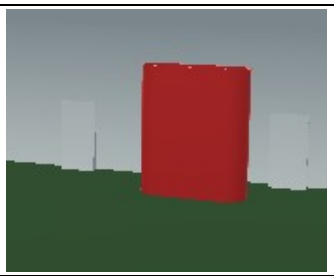
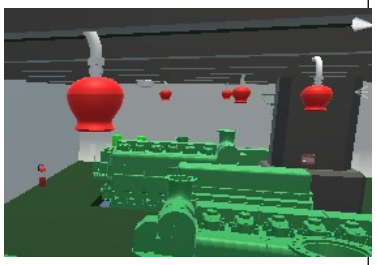
Description	Virtual Model	description
Dry Powder Fire Extinguisher		Dry Powder Fire Extinguisher is a dry chemical extinguisher used on class A, Class B and Class C : 1.Fire involving flammable solids, such as paper, wood, and textiles (class A fire). 2.Fire involving flammable liquid such as diesel, petrol, and paint (class B fire) 3.Fire involving electrical equipment, computers, switchboard, etc. (class C fire).

40 mm Ø Fire Hydrant		Fire Hydrant is a connection point that can be used for water supply. The diameter of a fire hydrant is 40mm
Fire Hose Box Containing 40 Mm X 15 M.		Fire Hose is a hose that carries water to extinguish a fire with high pressure. The fire hose box contains a hose of 40mm x 15 m
General/Fire Alarm Bell		General alarm in a ship is sounded to make aware the crew onboard that an emergency has occurred such as fire, collision, grounding, or a scenario which can lead to abandoning ship etc.
Fireman's Axe		Fireman's axe has a long handle and ahead with a spike and a cutting edge. On pleasure craft, any type of axe is acceptable, including a hatchet. Store axes in a readily accessible area. In an emergency, an axe can be used to cut a tow line.
Manual operated call point		Manual Alarm Call Point is designed for the purpose of manually triggering an alarm after a fire has occurred, by pressing the button or breaking the glass. The alarm signal can be triggered.

Control panel for fire detection & alarm system		A fire alarm system panel has a number of devices working together to detect and warn the crew onboard through visual and audio appliances when smoke, fire, carbon monoxide or other emergencies are present.
Push button for general alarm		General alarm in a ship is sounded to make aware the crew onboard that an emergency has occurred such as fire, collision, grounding, or a scenario which can lead to abandoning ship etc.
Remote ventilator closing		Remote Ventilation is to permit a rapid shutdown and effective closure of the ventilation system from outside of the space in case of fire.
Smoke detector		Smoke detectors are placed at various locations on the ship to detect the presence of smoke and avoid an emergency on board.
Heat detector		A heat detector is a sensor device designed to give a signal and respond when heat energy from fire increases the temperature of a heat-sensitive element.
Fire control plan (out deck must be in steel bucket)		The fire control plan provides information about fire station on each deck of the ship. It also explains the type of fire detection system and fire fighting system available on the ship

		
Fire Main Isolating Valve		The isolation valve in a fluid handling system serves to stop the flow to a particular location, usually for maintenance or safety purposes.
CO2 Alarm		The audible alarms shall be located so as to be audible throughout the protected space with all machinery operating, and the alarms should be distinguished from other audible alarms by adjustment of sound pressure or sound patterns. The alarm should activate upon opening the release cabinet door, which is used to open and release the CO2 bottle banks.
Fire Pump / GS Pump		The general service pump lines are interconnected with the fire main and at times are used to provide water to the fire system.
CO2 Release Station		CO2 release station is a pilot release box for activating CO2 gas to extinguish the fire by eliminating the oxygen.

EEBD		An Emergency Escape Breathing Device (EEBD) is a life-saving appliance which is used for escaping an area with hazardous conditions such as fire, smoke, poisonous gases etc. As the name mentions, it is used for a quick escape from a situation wherein the individual has to vacate his immediate surroundings swiftly.
Emergency Generator		Emergency Generator is a small separate generator which supplies the electric power for emergency load in the event of primary power supply failure. It is located outside the main and auxiliary machinery space and not forward of the collision bulkhead. It has its own switchboard near vicinity. It is provided with independent means of automatically starting (by air or battery) to ensure immediate run-up following a primary power failure and repeated starts of at least three times, and further attempt can be made within the 30 minutes.
Fireman Outfit		Fireman outfit is used on board ships to fight the emergency fire. The firefighter outfit is stored in the fire control room and in places that are easily accessible during emergencies.
International Shore Connection		The international shore connection is a universal hose connection that is to be provided on all ships as per the IMO SOLAS Requirement. The purpose of the International Shore Coupling is to keep a standby hose attachment to get a connection from shore or from other ships for shipboard firefighting, in case there is a total failure of pumps onboard.

Portable Foam Applicator		A portable foam applicator unit shall consist of a foam nozzle of an inductor type capable of being connected to the fire main by a fire hose, together with a portable tank containing at least 20 / of foam-forming liquid and one spare tanks of foam making a liquid.
Water Fog Applicator		Water droplets from this high-pressure fog applicator will reduce the fire ground temperature to allow firefighters to gain access. Some of the droplets will turn into steam and absorb heat from the fire, and the remaining will wet the surface of nearby combustible materials to delay combustion.
Wheeled Foam Extinguisher		Wheeled Foam Extinguisher placed in high-risk locations with limited access Survitec's range of wheeled extinguishers allow the user to fight fires from a long-distance giving protection from heat and fire. Wheeled extinguishers provide the ability to move high capacity extinguishers closer to the fire easily quickly.

4.5.2. Inspection Mode

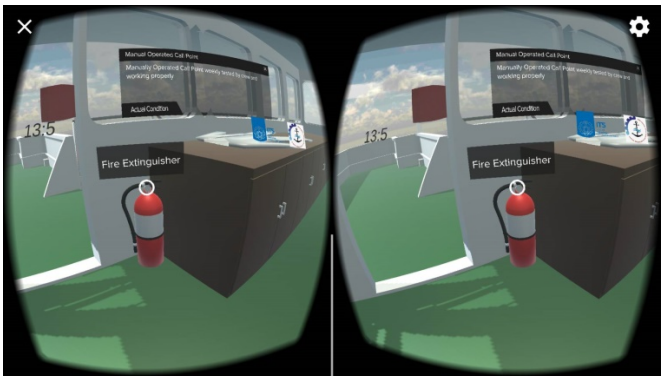


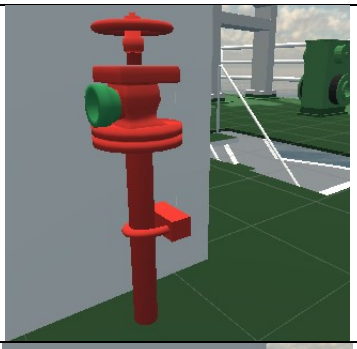
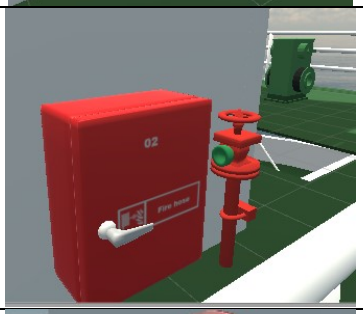
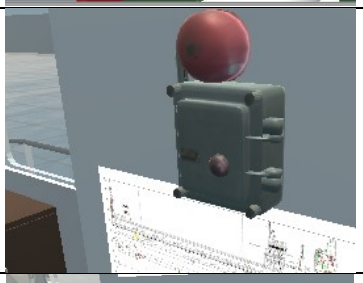
Figure 4.15 Inspection Mode User Interface
Source : By Author

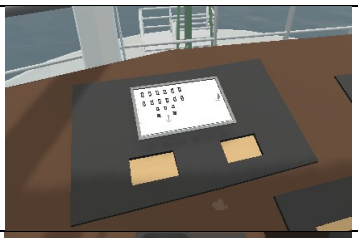
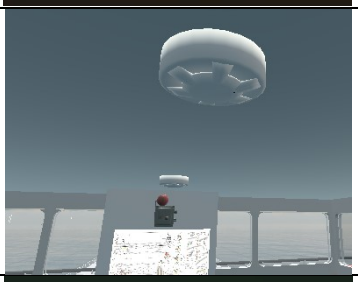
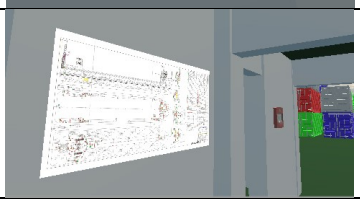
Figure 4.16 Fire Fighting Appliances list
Source: By Author

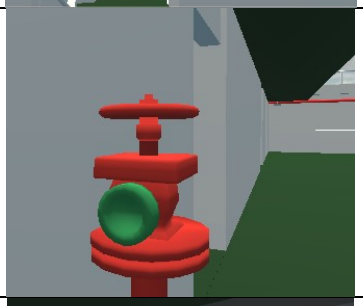
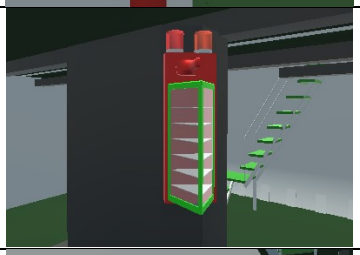
Inspection mode is a mode to training the inspector with a mission in the application, and the user must finish the mission within 15 minutes by finding all the fire fighting appliances as shown in figure 4.16 and full filling the inspection report by considering the actual condition of Fire Fighting Equipment.

Table 4.5 Equipment Real Condition Statement

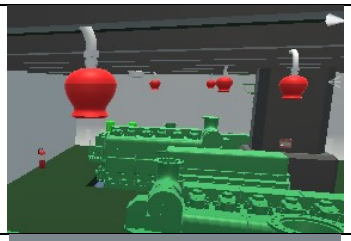
Description	Virtual Model	description
Dry Powder Fire Extinguisher		1. Pressure gauge in work condition 2. The body condition little bit corrosion 3. Placed inappropriate with a fire plan

40 mm Ø Fire Hydrant		1. Leakage around the flange and seals 2. The nozzle is in good working condition
Fire Hose Box Containing 40 Mm X 15 M.		1. The nozzle controls need to be adjusted 2. No damage in hose
General/Fire Alarm Bell		1. Fire Alarm Bell is working correctly but the sound not louder enough 2. Testing inspection is frequently record
Fireman's Axe		Some Fireman Axe not placed as it should be.
Manual operated call point		Manually Operated Call Point weekly tested by the crew and working properly

Control Panel for fire detection & alarm system		1. Control Panel is working correctly by checked and tested 2. The display in clear visibility
Push button for general alarm		Push Button for general alarm is working properly
Remote ventilator closing		Remote Control for Emergency Fire Pump is working properly
Smoke detector		Smoke detector sensor need to calibrate
Heat detector		The heat detector sensor function is working properly
Fire control plan (out deck must be in steel bucket)		1. Fire Plan is located in accordance with the Fire Safety Plan 2. Outside fire plan is put on bucket weatherproof

		
Fire Main Isolating Valve		1. Leakage around the flange and seals 2. The nozzle is in good working condition
CO2 Alarm		The alarm sound is in good condition and working correctly.
Fire Pump / GS Pump		General Service Pump is working properly but, there is a leakage in packing bearing.
CO2 Release Station		CO2 release station is working correctly and in good condition.

EEBD		1. EEBD is in good condition and ready to use immediately 2. EEBD is placed according to the fire plan
Emergency Generator		Emergency Generator is ready to use immediately
Fireman Outfit		Fire Man Outfit is in place according to fire plan and in good condition ready to use immediately
International Shore Connection		International Shore Connection not placed as it should be.
Portable Foam Applicator		Portable Foam Applicators are in place, properly arranged, and are in proper condition.

Water Fog Applicator		Water fog applicator is working correctly, and the mist spirt out as it should be
Wheeled Foam Extinguisher		Wheeled Foam Extinguisher are in place, properly arranged, and are in proper condition.

4.5.2.1. Inspection Report

Figure 4.17 Inspection Report User Interface

The question and the recommendation answer will appear in the application in inspection mode as table 4.4 and table 4.5. The inspection checklist question will be compy from CMID (Common Marine Inspection Document). CMID is the document that has a purpose of providing the marine industry with a standardised format for vessel inspection reports and to reduce the number of inspections carried out on individual marine vessels, through the adoption of a common inspection process. (CMID, 2016)

Table 4.6 Inspection Question

NO	QUESTION
1	Is the vessel provided with fixed fire fighting equipment in accordance with applicable regulations for vessel type?
2	Is the certificate from each fire fighting equipment available?
3	Is sufficient fire fighting equipment available for use and defect-free?
4	Are records of fire fighting equipment maintenance available?
5	Are fixed fire and gas detection systems fully operational and tested regularly accompanied by a test document?
6	Are vessel personnel familiar with the operation of fire fighting, life-saving and other emergency equipment?
7	Any manual operation guide to be posted on each fire fighting appliances?
8	Are measures in place to effectively isolate ventilation to enclosed spaces, e.g. engine room, accommodation, galley, storerooms?

Table 4.7 Inspection Answer Recommendation

No	Answer Recommendation
1	• The emergency fire pump is fully operational and regularly checked. • Fire valves, pipeline, pumps, hoses and nozzles find in good condition and ready for immediate use. • Instruction is Posted
2	• The certificate is available • Partially certificate is available • There is no certificate at all
3	• All fire safety equipment is defect-free and ready for use • Fire equipment placed as per fire plan • Equipment checked and maintained well • crew properly trained.
4	• Records of maintenance available and kept according to ISM. • Records of maintenance available but not according to ISM.
5	• The fire detection system is operational and monthly tested. • The Gas Detection system is operational and monthly tested.
6	• All ship personnel is familiar and trained with such operations. • Not all ship personnel is familiar with such operation
7	• Fans emergency stops are operational and clear marked. • Vent ducts have manually operated dampers, which are operational and well maintained
8	• Remote ventilation closing is working correctly and in good condition • Partially remote working in good condition, and partially not.

4.6. User Assessment Questionnaire Form

The VR application needs to be testing. The test was doing intending to find errors and deficiencies in the software. The test is intended to determine whether the software is made to meet the criteria under the purpose of software design by using a questionnaire form.

The questionnaire is a tool to assess and test the virtual reality application, and give the feedback to develop and complete the shortcomings. The form is available in an online questionnaire that the link can be scanned by QR Code and directly go to the website of the online form, in www.bit.ly/MarineVRapp and in the form of paper-based. The questionnaire is also available in Bahasa to make them understandable for the respondent that did not understand in English.

The questionnaire is consist of ten questions that's the last three question is especially for surveyor as a respondent. The respondent must be given a score that's stated by number range of five (5) until one (1). The excellent score is 5, and the lousy score is 1. The question is:

1. Is the display in this VR application easy to understand?
2. Do all the button, and each fire fighting appliances displayed work properly?
3. Does the object displayed represent fire fighting equipment on board?
4. Is learning with VR technology more interesting, helpful and easy learning?
5. When using VR glasses, is the VR application comfort to used?
6. Are learning and training using VR be conveyed compared to face-to-face learning?
7. Does the inspection training use VR adequately illustrate hands-on learning on board?
8. If you are a surveyor, is the placement of the object in accordance with the Fire Safety Plan?
9. If you are a surveyor, Is this Virtual Reality application very helpful for surveyor training purposes?
10. If you wish, write down the brand and type of your smartphone to match the compatibility of the application with the specifications of your smartphone

4.6.1. Questionnaire Results

These following are the total results of collecting data from each answer from ten respondent that filled the questionnaire online or paper-based; it can be seen in Table 4.8 below.

Table 4.8 Questionnaire Results

No	Criteria	Respondent					Total
		5	**4**	**3**	**2**	**1**	
1	Is the display in this VR application easy to understand? *	6	4	0	0	0	10
2	Do all the button, and each fire fighting appliances displayed work properly? *	5	4	1	0	0	10
3	Does the object displayed represent fire fighting equipment on board? *	5	2	3	0	0	10
4	Is learning with VR technology more interesting, helpful and easy learning? *	5	5	0	0	0	10
5	When using VR glasses, is the VR application comfort to used? *	0	3	5	2	0	10
6	Can learning and training using VR can be delivered and be a complement it with face-to-face learning? *	3	5	2	0	0	10
7	Does the inspection training using VR adequately illustrate hands-on learning on board? *	2	6	2	0	0	10
8	If you are a surveyor, is the placement of the object in accordance with the Fire Safety Plan?	2	5	3	0	0	10
9	If you are a surveyor, Is this Virtual Reality application very helpful for surveyor training purposes?	2	7	1	0	0	10
10	If you wish, write down the brand and type of your smartphone to match the compatibility of the application with the specifications of your smartphone	1. Samsung S10 2. Samsung A50 3. Realme 3Pro 4. Vivo 1806					

4.6.2. Questionnaire Results Analysis

From the results of questionnaire data collection, a score and percentage calculation can be made for each question given. To find the percentage of each answer to the questionnaire used the Likert scale formula as follows:

$$P = \frac{S}{Ideal\ Score}\ x\ 100\%$$

The description of the formula for calculates score and percentage value of the questionnaire answers can be seen in the following table 4.9.

Table 4.9 Formula Description

Name	Description
P	Percentage value.

S	The number of times the frequency is multiplied by the score in the answer.
Ideal Score	Highest score multiply by the number of samples
Highest Score	5
Sample	10 Respondent
Ideal Score	5 x 10 Respondent = 50

So these below is score and percentage calculation from each answer, As for the explanations as follows:

1. Is the display in this VR application easy to understand?

Table 4.10 Question No.1 Calculation

Score	Respondent	Total Score
5	6	30
4	4	16
3	0	0
2	0	0
1	0	0
Total	10	46
Average Score		4,6

Then the calculation is as follows :

$$P = \frac{46}{50}\ x\ 100\% = 92\%$$

Then we can conclude that the VR application is easy to understand.

2. Do all the button, and each fire fighting appliances displayed work properly?

Table 4.11 Question No.2 Calculation

Score	Respondent	Total Score
5	5	25
4	4	16
3	1	3
2	0	0
1	0	0
Total	10	41
Average Score		4,1

Then the calculation is as follows :

$$P = \frac{41}{50}\ x\ 100\% = 82\%$$

Then we can conclude that all the button and each fire fighting appliances displayed is working properly.

3. Does the object displayed represent fire fighting equipment on board?

Table 4.12 Question No.3 Calculation

Score	Respondent	Total Score
5	5	25
4	3	12
3	2	6
2	0	0
1	0	0
Total	10	43
Average Score		4,3

Then the calculation is as follows :

$$P = \frac{43}{50}\ x\ 100\% = 86\%$$

Then we can conclude that all the object displayed already represent fire fighting equipment on board.

4. Is learning with VR technology more interesting, helpful and easy learning?

Table 4.13 Question No.4 Calculation

Score	Respondent	Total Score
5	5	25
4	5	20
3	0	0
2	0	0
1	0	0
Total	10	45
Average Score		4,5

Then the calculation is as follows :

$$P = \frac{45}{50}\ x\ 100\% = 90\%$$

Then we can conclude that learning with VR technology more interesting, helpful and easy learning.

5. When using VR glasses, is the VR application comfort to used?

Table 4.14 Question No.5 Calculation

Score	Respondent	Total Score

5	0	0
4	3	12
3	5	15
2	2	4
1	0	0
Total	10	31
Average Score		3,1

Then the calculation is as follows :

$$P = \frac{31}{50}\ x\ 100\% = 62\%$$

Then we can conclude that the VR application comfort enough to used. Its because the mostly user feel sickness motion, that occure of headache due to eye unfamiliarity for using VR glasses, also the low graphic quality become a small cause and the low specification of VR glasses.

6. Can learning and training using VR can be delivered and be a complement it with face-to-face learning? *

Table 4.15 Question No.6 Calculation

Score	Respondent	Total Score
5	3	15
4	5	20
3	2	6
2	0	0
1	0	0
Total	10	41
Average Score		4,1

Then the calculation is as follows :

$$P = \frac{41}{50}\ x\ 100\% = 82\%$$

Then we can conclude that learning and training using VR can be conveyed to face-to-face learning and be a complement with.

7. Does the inspection training use VR adequately illustrate hands-on learning on board?

Table 4.16 Question No.7 Calculation

Score	Respondent	Total Score
5	2	10
4	6	24
3	2	3
2	0	0

1	0	0
Total	10	37
Average Score		3,7

Then the calculation is as follows :

$$P = \frac{37}{50}\ x\ 100\% = 74\%$$

Then we can conclude that inspection training use VR adequately illustrate hands-on learning on board.

8. If you are a surveyor, is the placement of the object in accordance with the Fire Safety Plan?

Table 4.17 Question No.8 Calculation

Score	Respondent	Total Score
5	2	10
4	5	20
3	3	9
2	0	0
1	0	0
Total	10	39
Average Score		3,9

Then the calculation is as follows :

$$P = \frac{39}{50}\ x\ 100\% = 78\ \%$$

Then we can conclude that the object in the application in accordance with the Fire Safety Plan.

9. If you are a surveyor, Is this Virtual Reality application very helpful for surveyor training purposes?

Table 4.18 Question No.9 Calculation

Score	Respondent	Total Score
5	2	10
4	7	28
3	1	3
2	0	0
1	0	0
Total	10	41
Average Score		4,1

Then the calculation is as follows :

$$P = \frac{41}{50}\ x\ 100\% = 82\%$$

Then we can conclude that Virtual Reality application was very helpful for surveyor training purposes.

10. If you wish, write down the brand and type of your smartphone to match the compatibility of the application with the specifications of your smartphone

Based on the percentage obtained through the calculation of the questionnaire for each question, then the percentage of the questionnaire can be calculated as a whole with the following Table 4.19 :

Table 4.19 Total Question Score

Question No.	Percentage Value	Total Score
1	92%	46
2	82%	41
3	86%	43
4	90%	45
5	62%	31
6	82%	41
7	74%	37
8	78%	39
9	82%	41
Total score		364
Total Average Score		4.04

To assess the results of the respondent's overall assessment of the quality of the application, the steps are:

1. Determine the maximum score, which is the largest answer score multiply by total questions, multiply by the total respondent.

   5 x 9 x (10 respondent) = 450

2. Determine the minimum score, which is the smallest answer score multiplied by total questions, multiply by the total respondent.

   1 x 9 x (10 respondent) = 90

3. Determine the median value, with the sum of the maximum total score with a minimum total score divided by two.

$$\frac{(500 + 100)}{2} = 270$$

4. Determine the quartile I value , with the sum of the minimum total score with a median divided by two.

$$\frac{(90\ +270)}{2} = 225$$

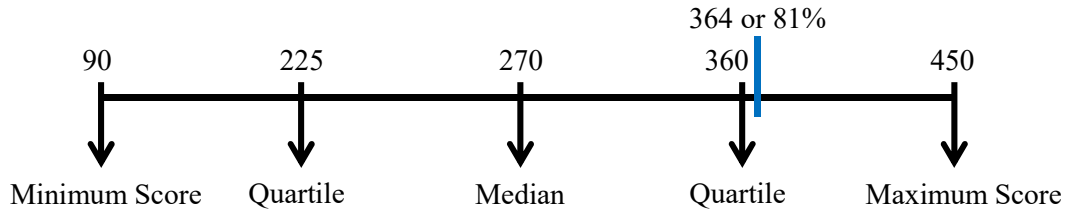
5. Determine the quartile III value, which is the sum of the maximum scores with the median divided by two

$$\frac{(450 + 270)}{2} = 360$$

Table 4.20 is an assessment categorized based on the value of the maximum score, quartile III, median, quartile I and the minimum score that calculated above.

Table 4.20 Category of overall application assessment

Excellent	Quartile III ≤ x ≤ Maximum Score	360 – 450
Good	Median ≤ x < Quartile III	270 – 360
Enough	Quartile I ≤ x ≤ Median	225 – 270
Bad	Minimum Score ≤ x ≤ Quartile I	90 – 225



Based on the results of the respondents of the 9 questions, it can be concluded that the virtuality application for training inspector for fire fighting appliances is an excellent category because the total value is 364 which is between 360 and 450 (maximum), which is the excellent category.

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CHAPTER 5
CONCLUSION AND SUGGESTION

5.1. Conclusion

Based on the objective of this application, it can be concluded that the application can develop and simulate fire safety appliances inspection by making a model of the real condition of the fire safety appliances into 3D modelling and install into a virtual reality application maker. And based on the user questionnaire result, this application in the excellent category because the total value is 364 which is between 360 and 450 (maximum), which is the excellent category. But there must be further development with improvement in high-quality resolution and detail of 3D models, and development on how to minimalize the motion sickness when the user using VR glasses.

5.2. Suggestion

The suggestion of this thesis are :

1. There must be further development with improvement in high quality resolution and detail of 3D models.
2. Better to use the virtual reality application for training inspection in high specification of VR glasses to minimalize sickness motion.
3. The application is an early development of virtual reality application to be applied in a ship model. There are many improvements that can be done by adding many features to the further development.

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APPENDIX I

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USER ASSESSMENT QUESTIONNAIRE FOR VIRTUAL REALITY APPLICATION FOR TRAINING INSPECTION OF FIRE FIGHTING APPLIANCES ON SHIP

Name : . . . . . .

Profession : . . . . . .

Give check (√) to the appropriate rating.
The highest score is expressed as a grade (5) and lowest (1)
Questions with a sign (*) are required
Questionnaire can be done online www.bit.ly/MarineVRapp or scan QR code

No	Criteria	Score				
		5	4	3	2	1
1	Is the display in this VR application easy to understand? *					
2	Do all the button, and each fire fighting appliances displayed work properly? *					
3	Does the object displayed represent fire fighting equipment on board? *					
4	Is learning with VR technology more interesting, helpful and easy learning? *					
5	When using VR glasses, is the VR application comfort to used? *					
6	Are learning and training using VR be conveyed compared to face-to-face learning? *					
7	Does the inspection training use VR adequately illustrate hands-on learning on board? *					
8	If you are a surveyor, is the placement of the object in accordance with the Fire Safety Plan?					
9	If you are a surveyor, Is this Virtual Reality application very helpful for surveyor training purposes?					
10	If you wish, write down the brand and type of your smartphone to match the compatibility of the application with the specifications of your smartphone	Merk : . . . . . . Type :				

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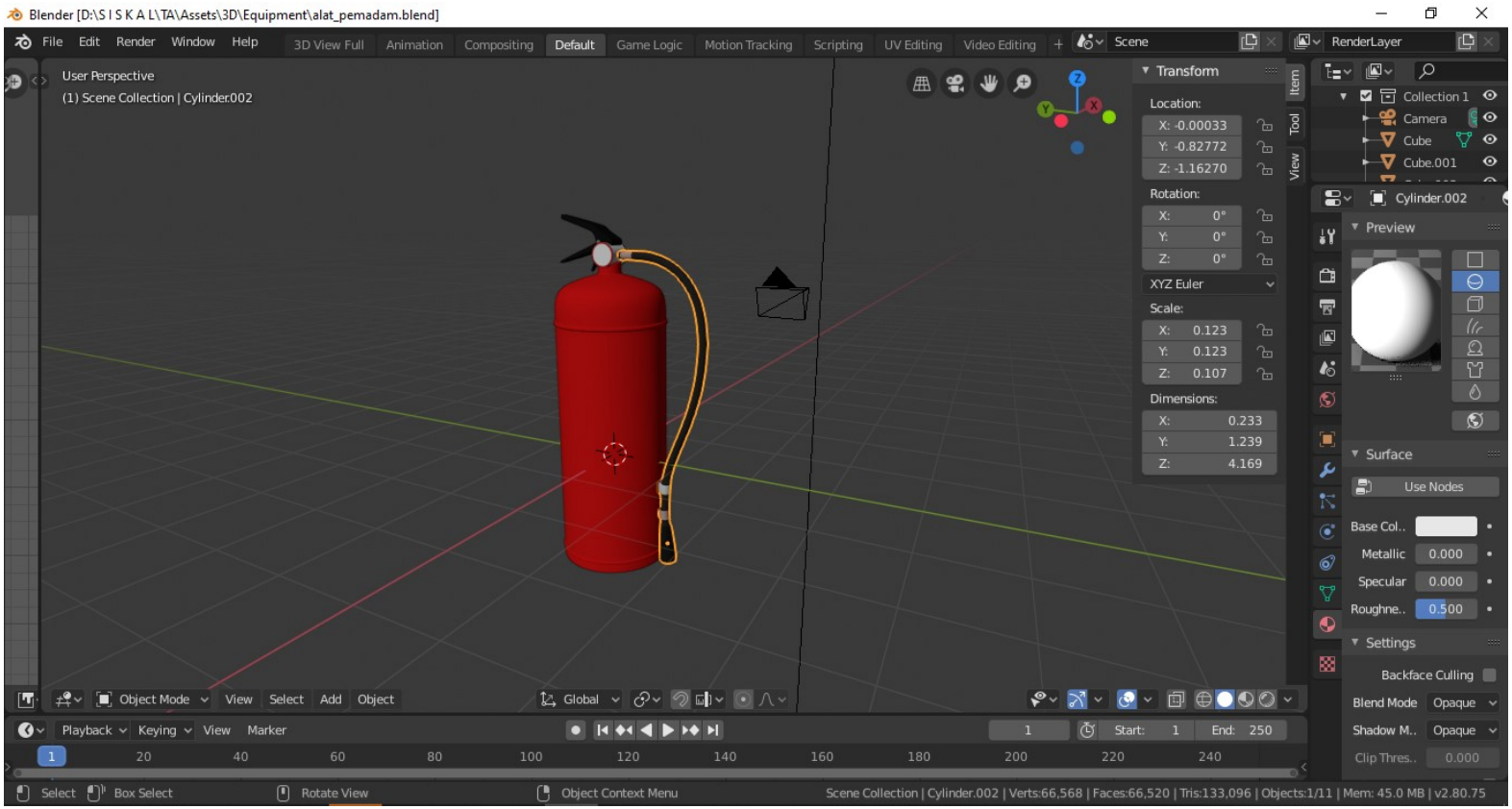

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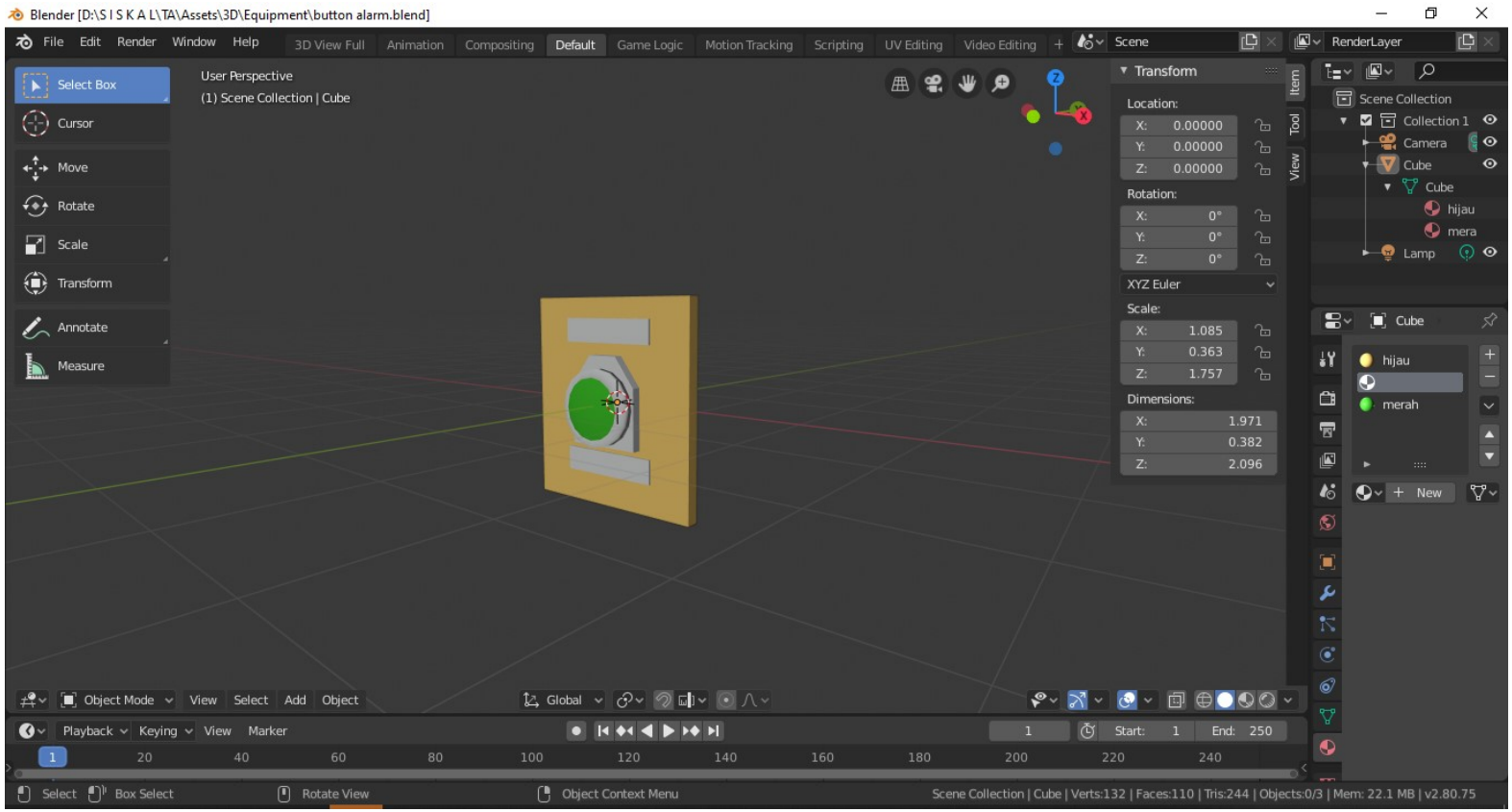

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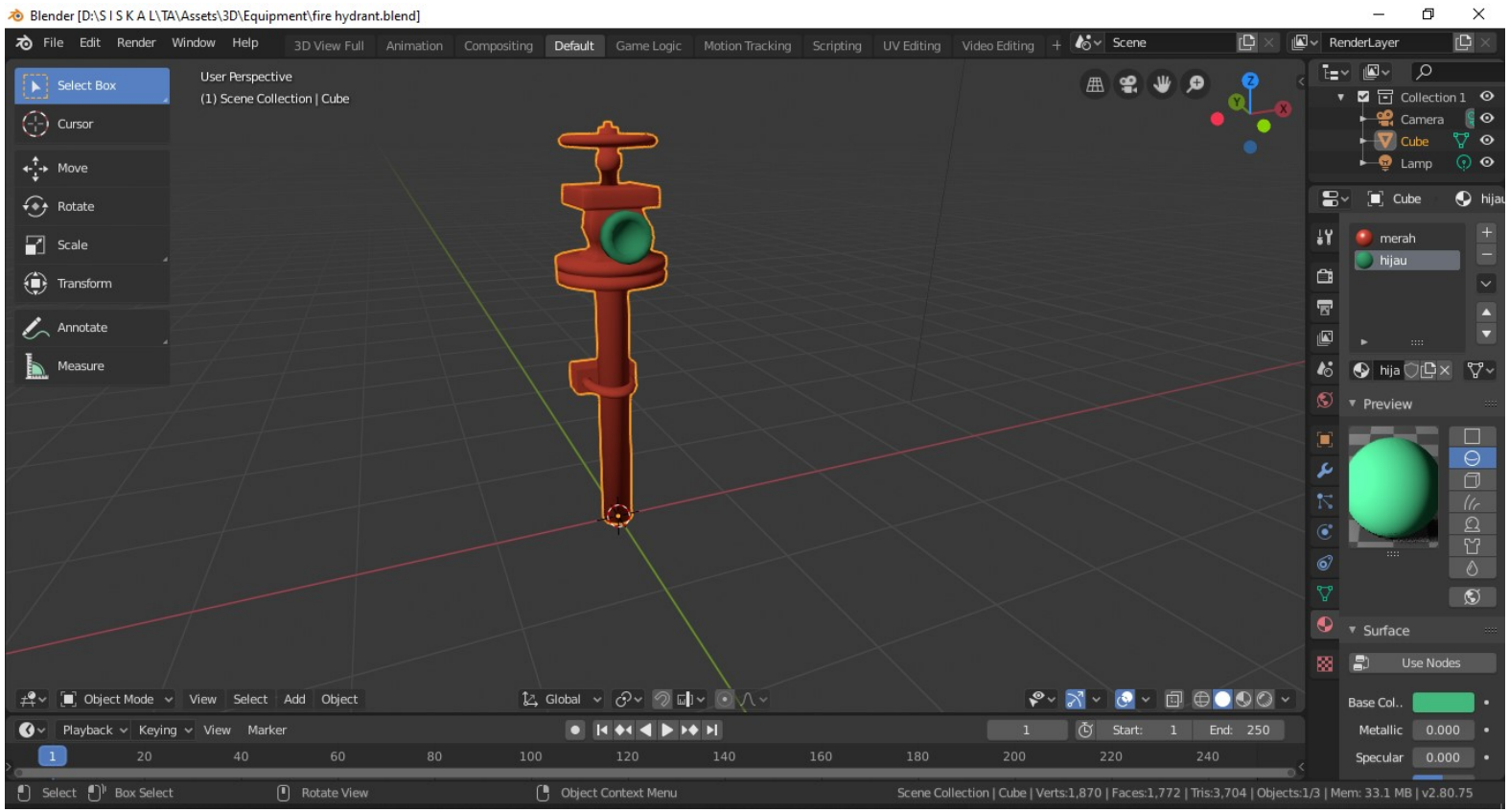

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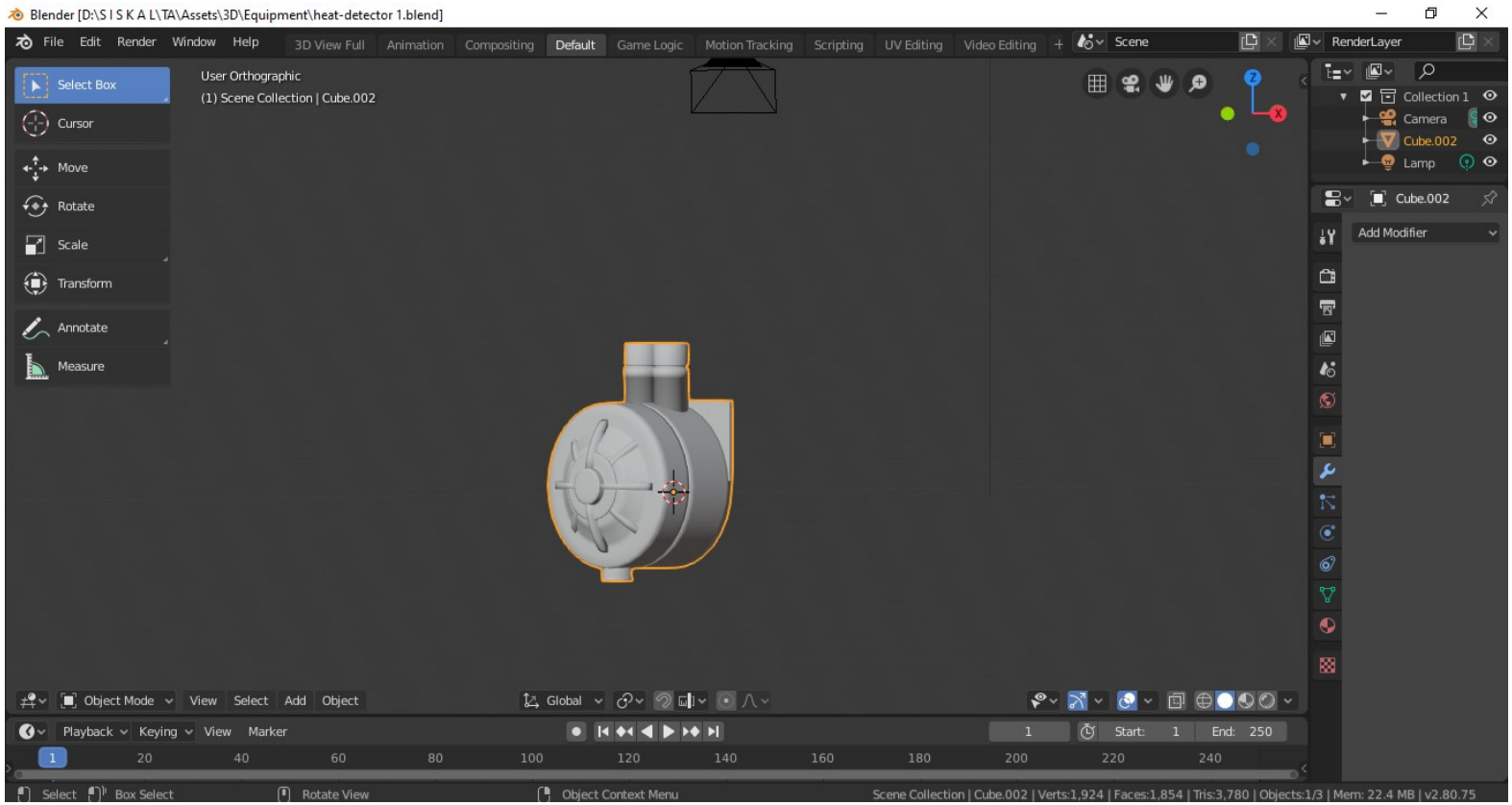

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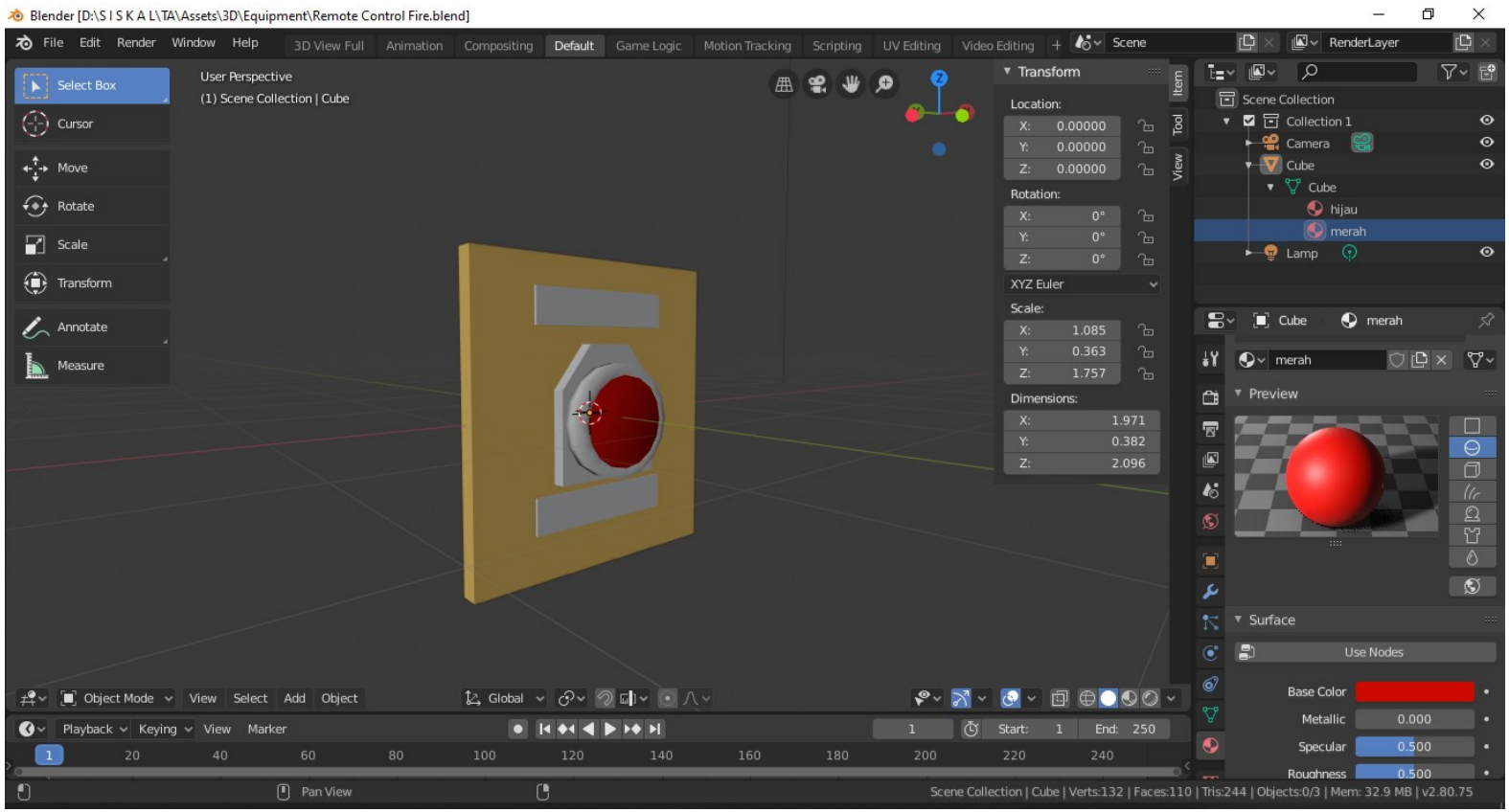

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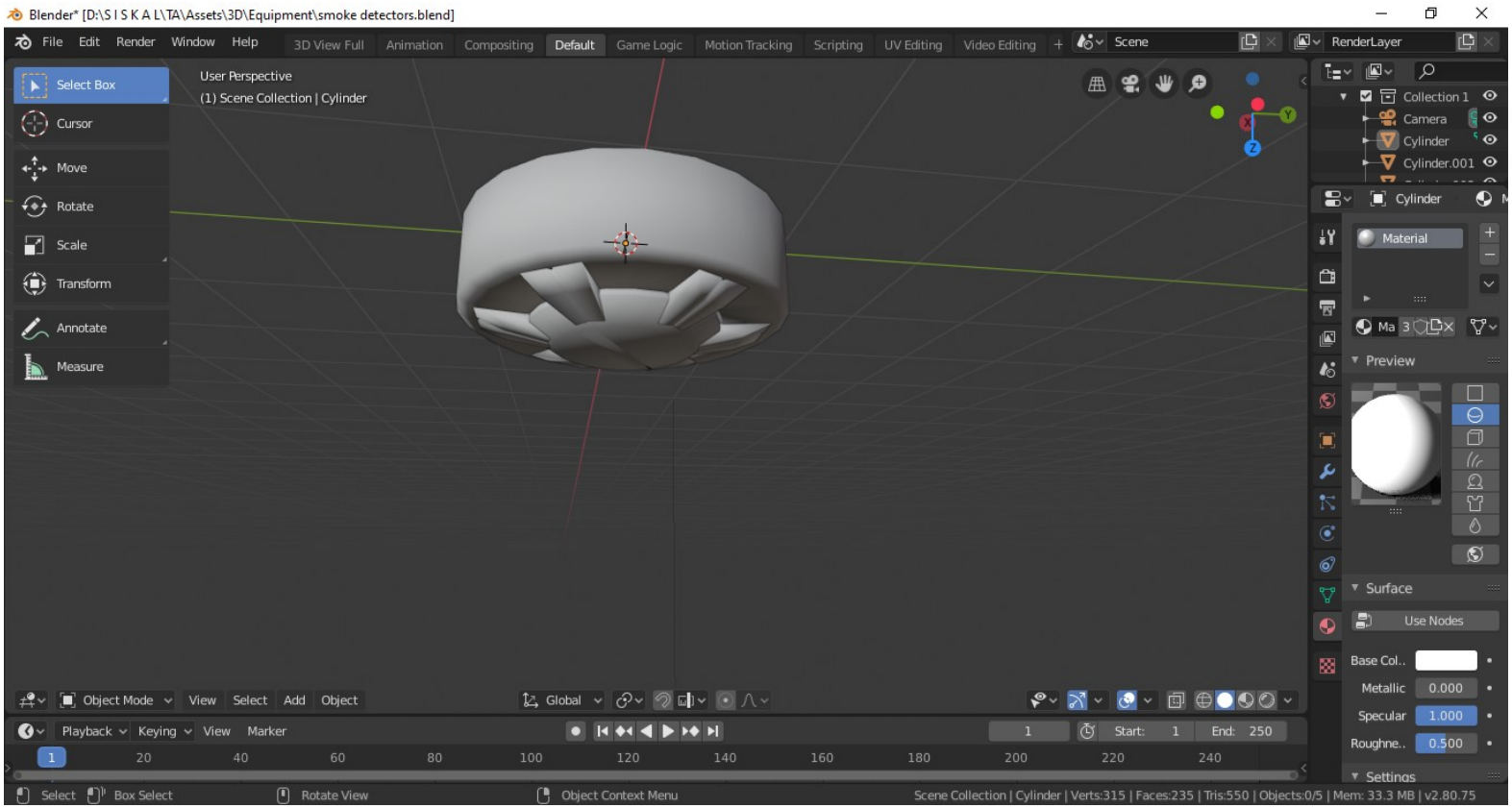

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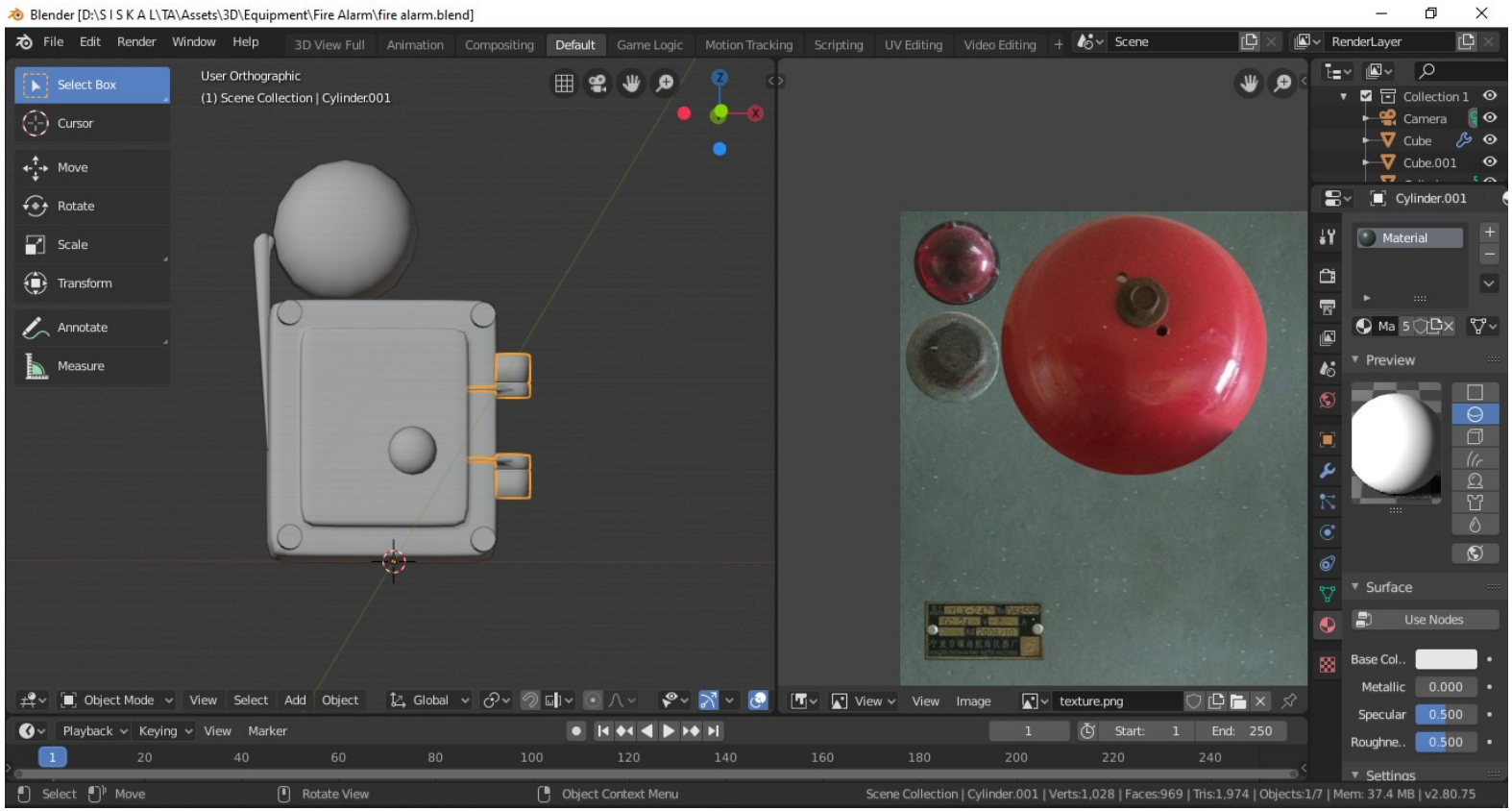

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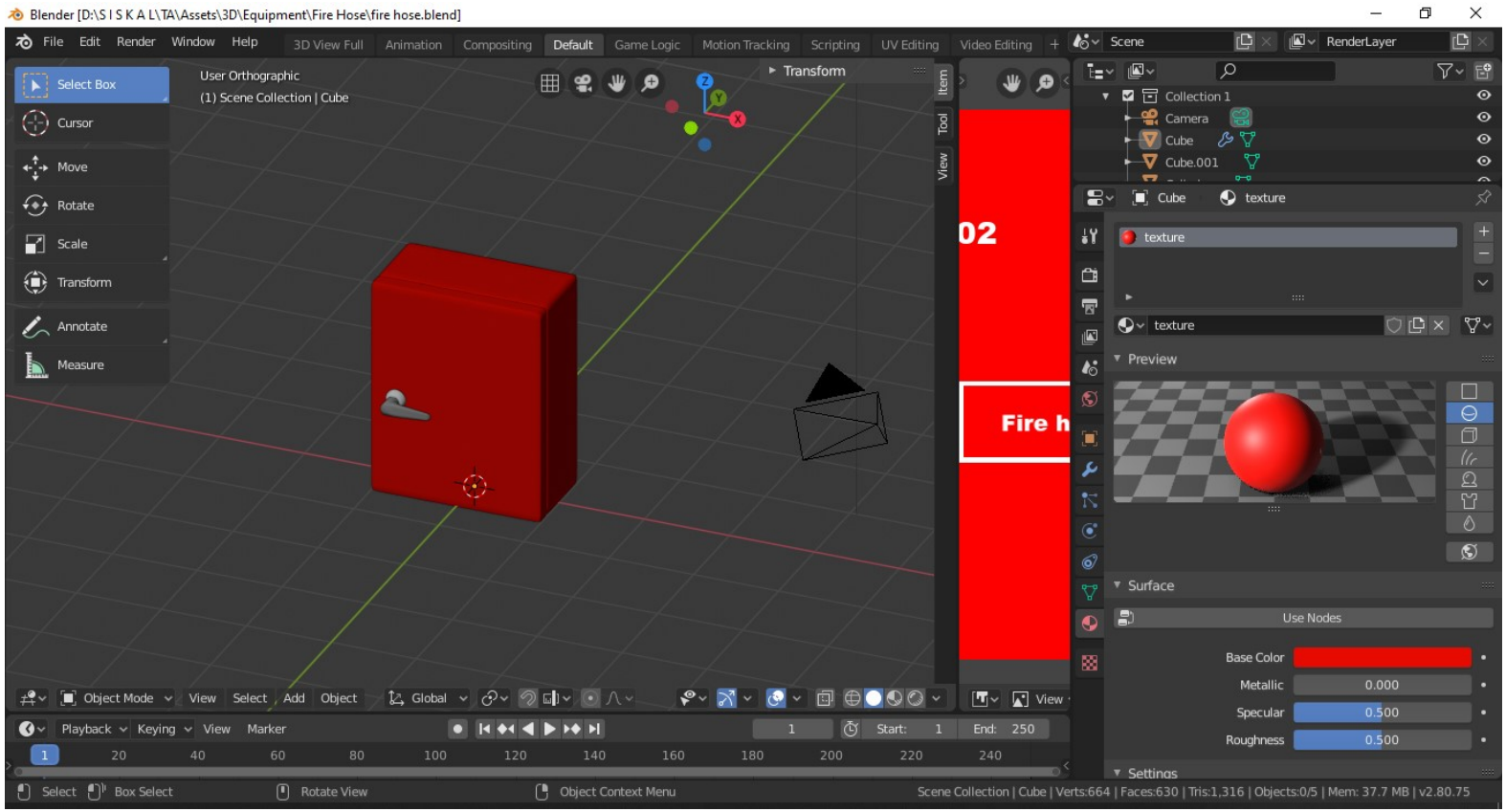

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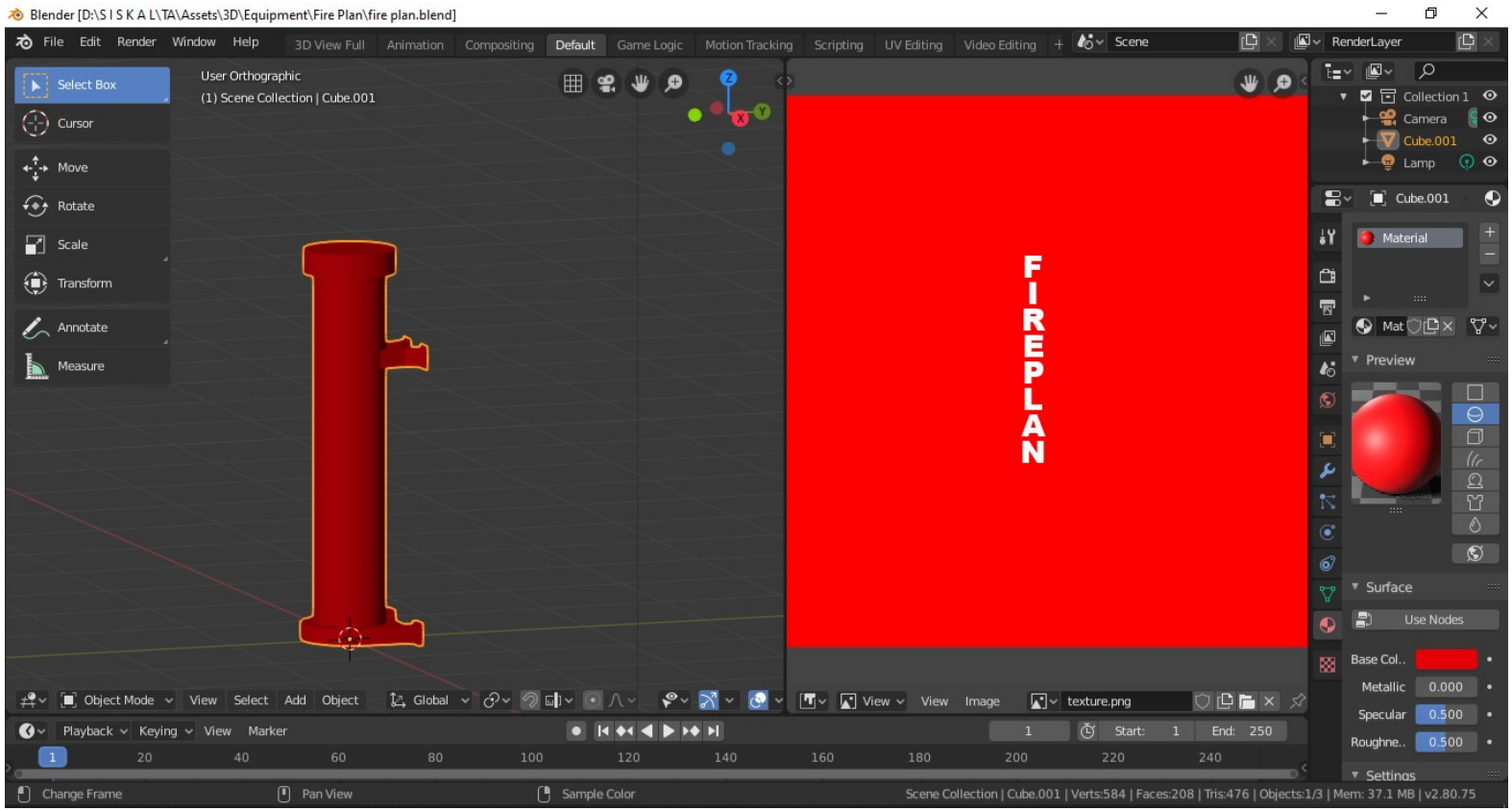

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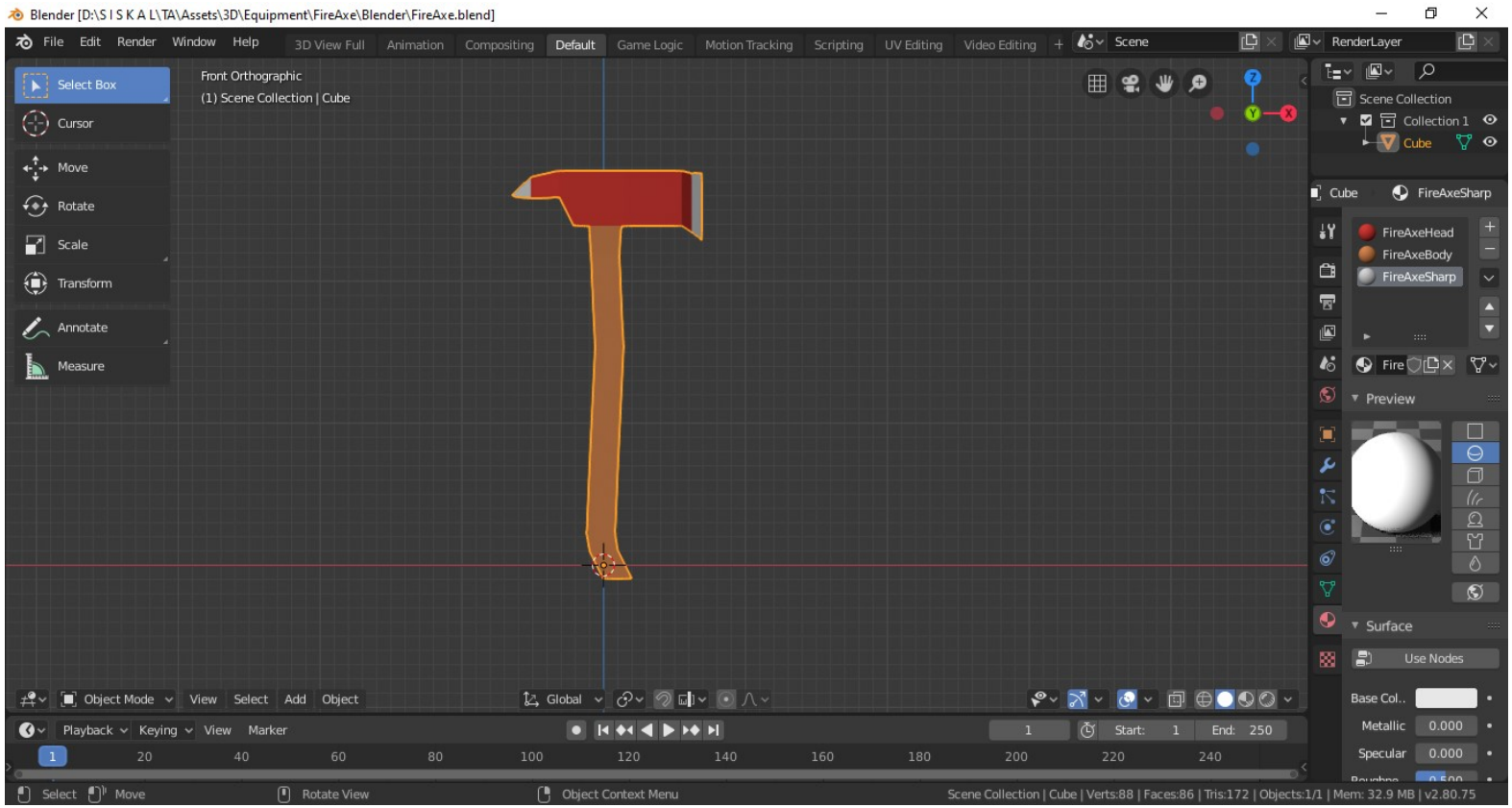

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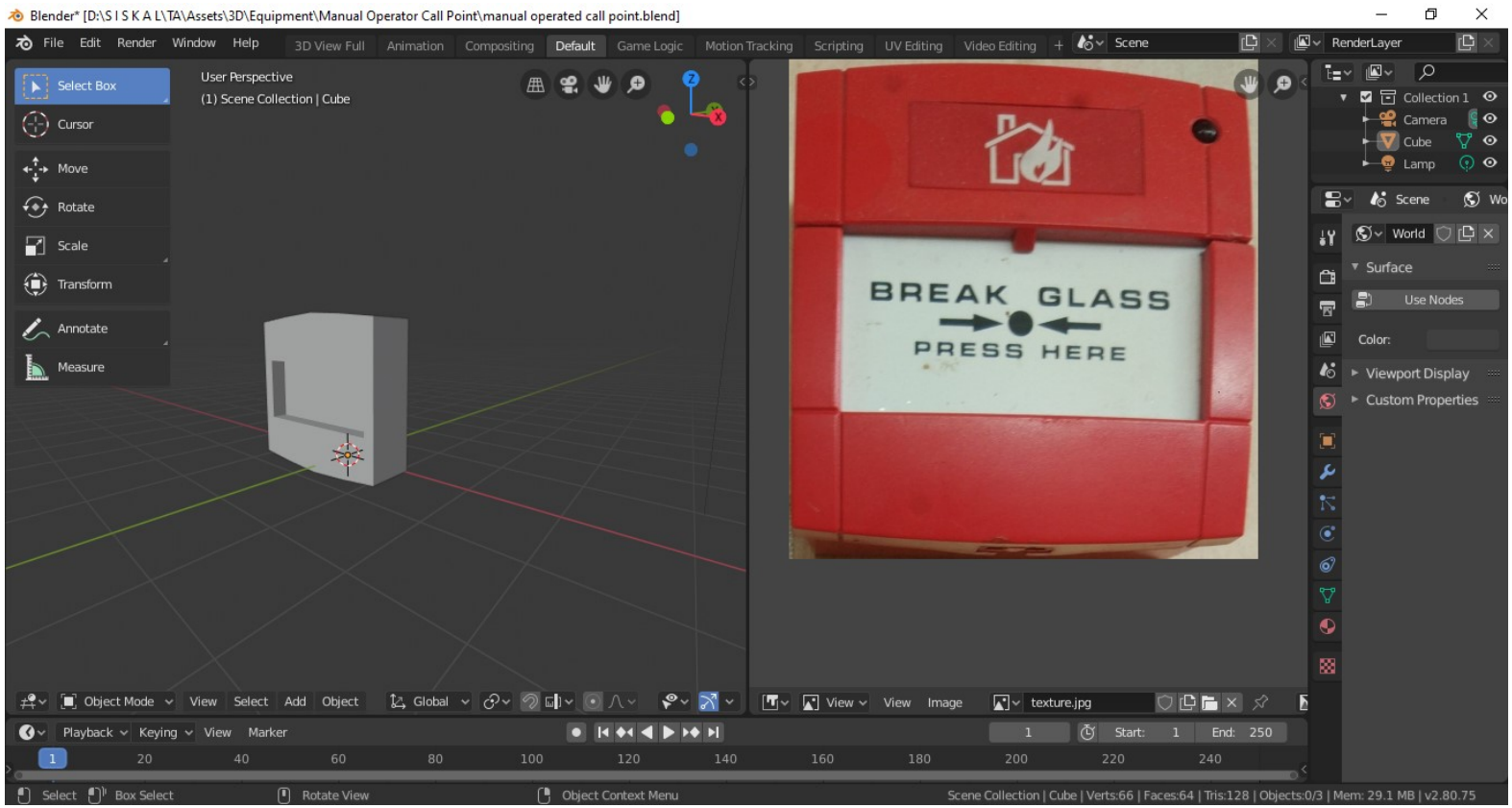

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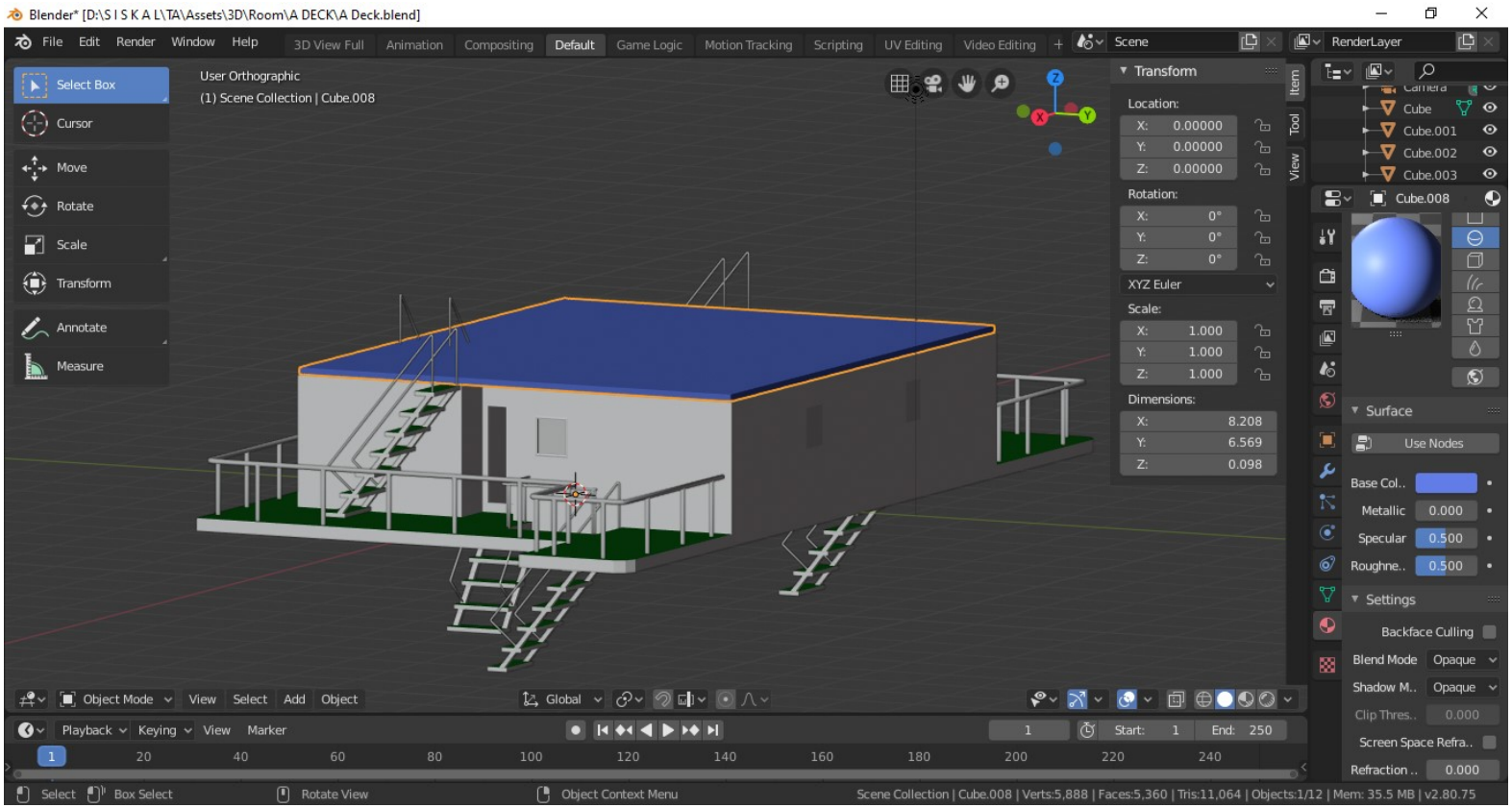

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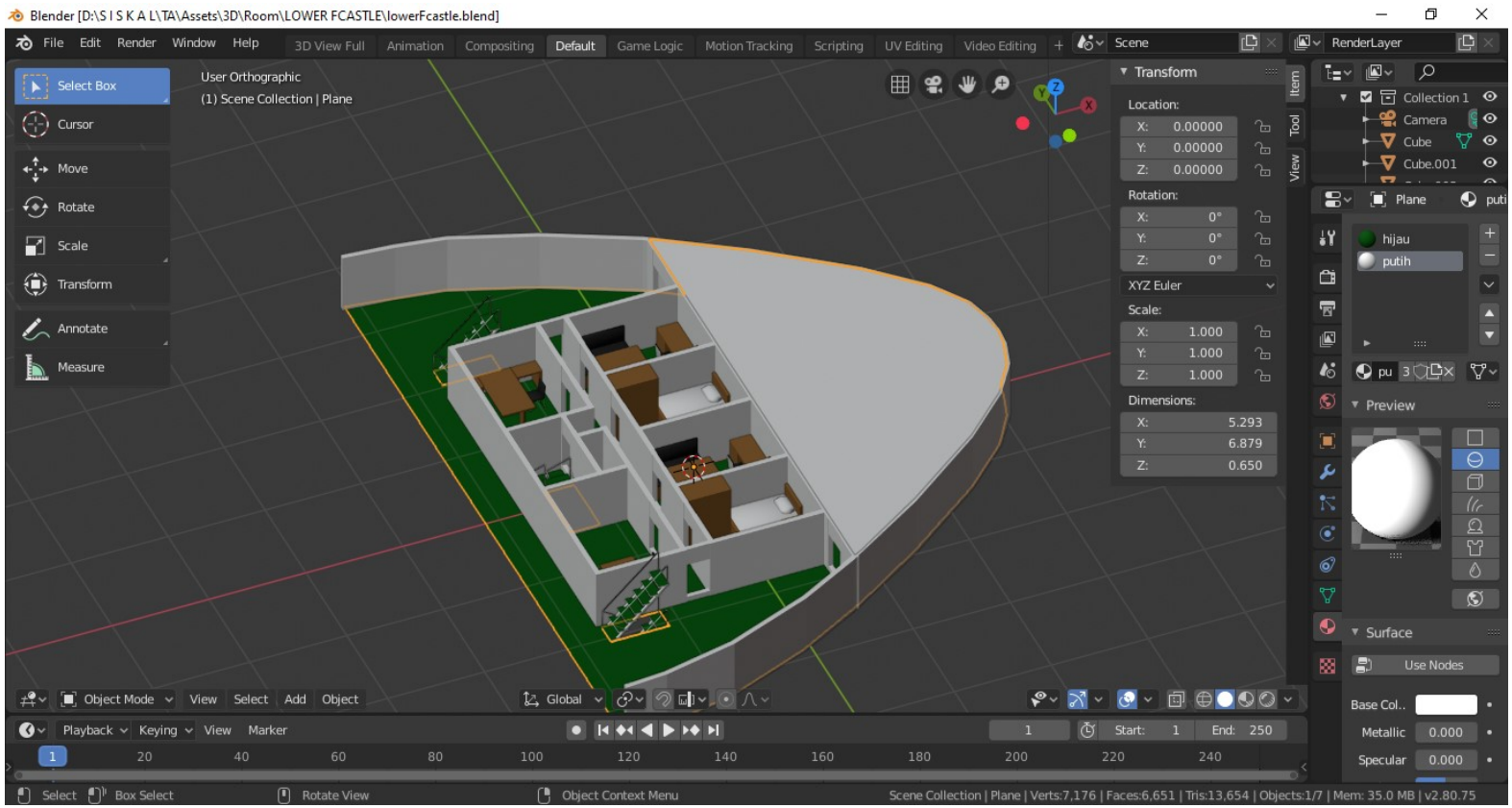

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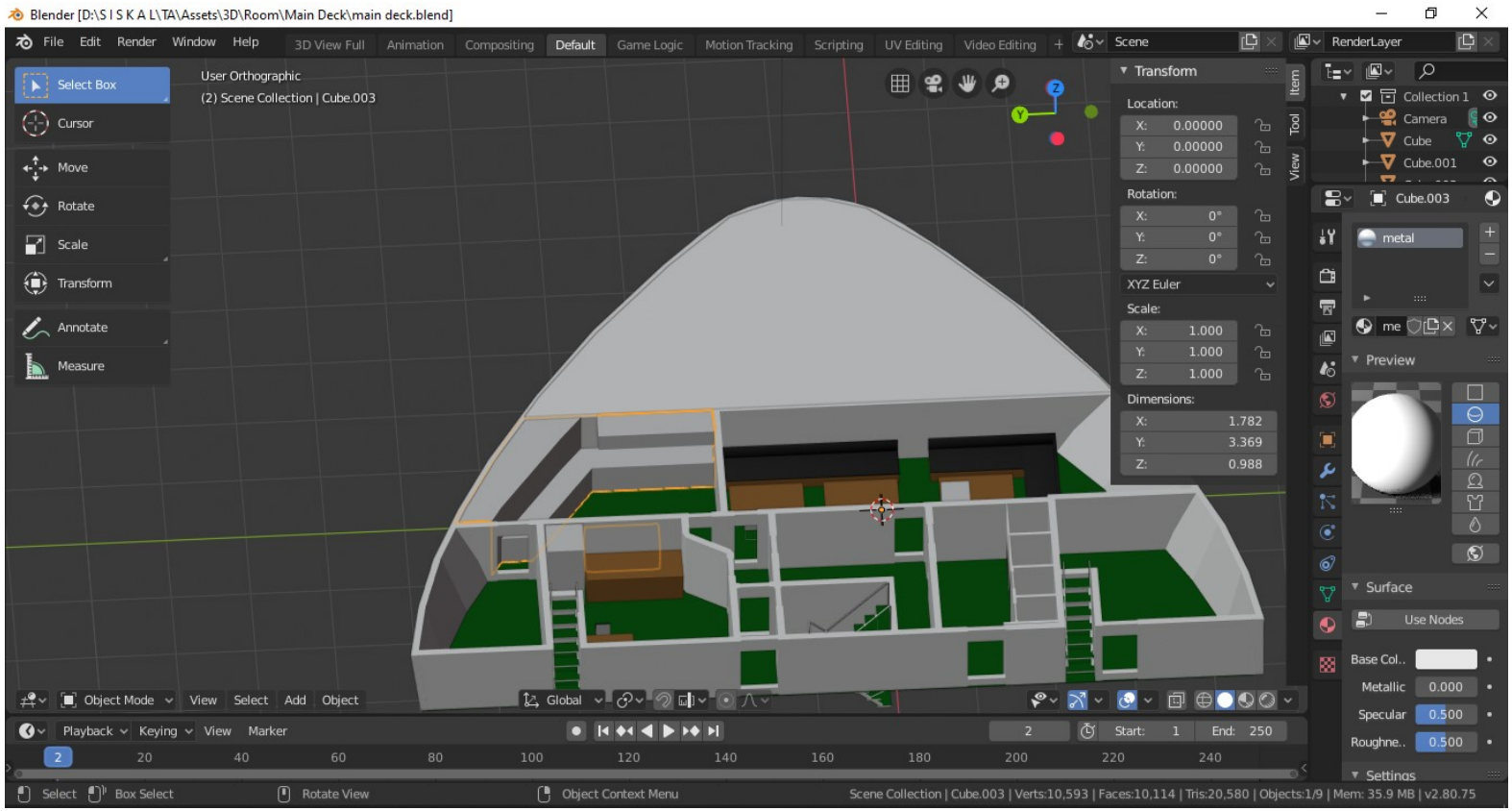

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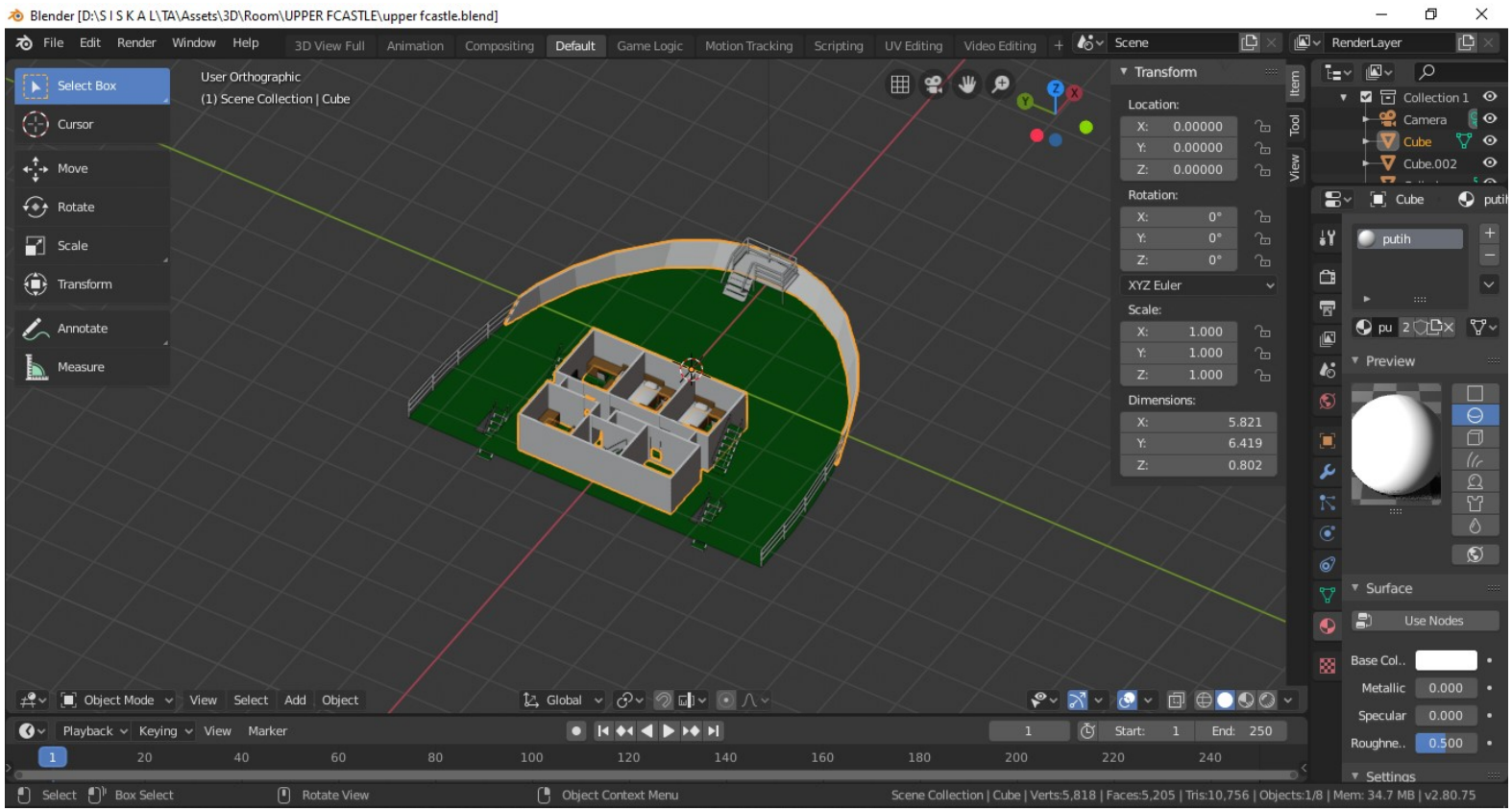

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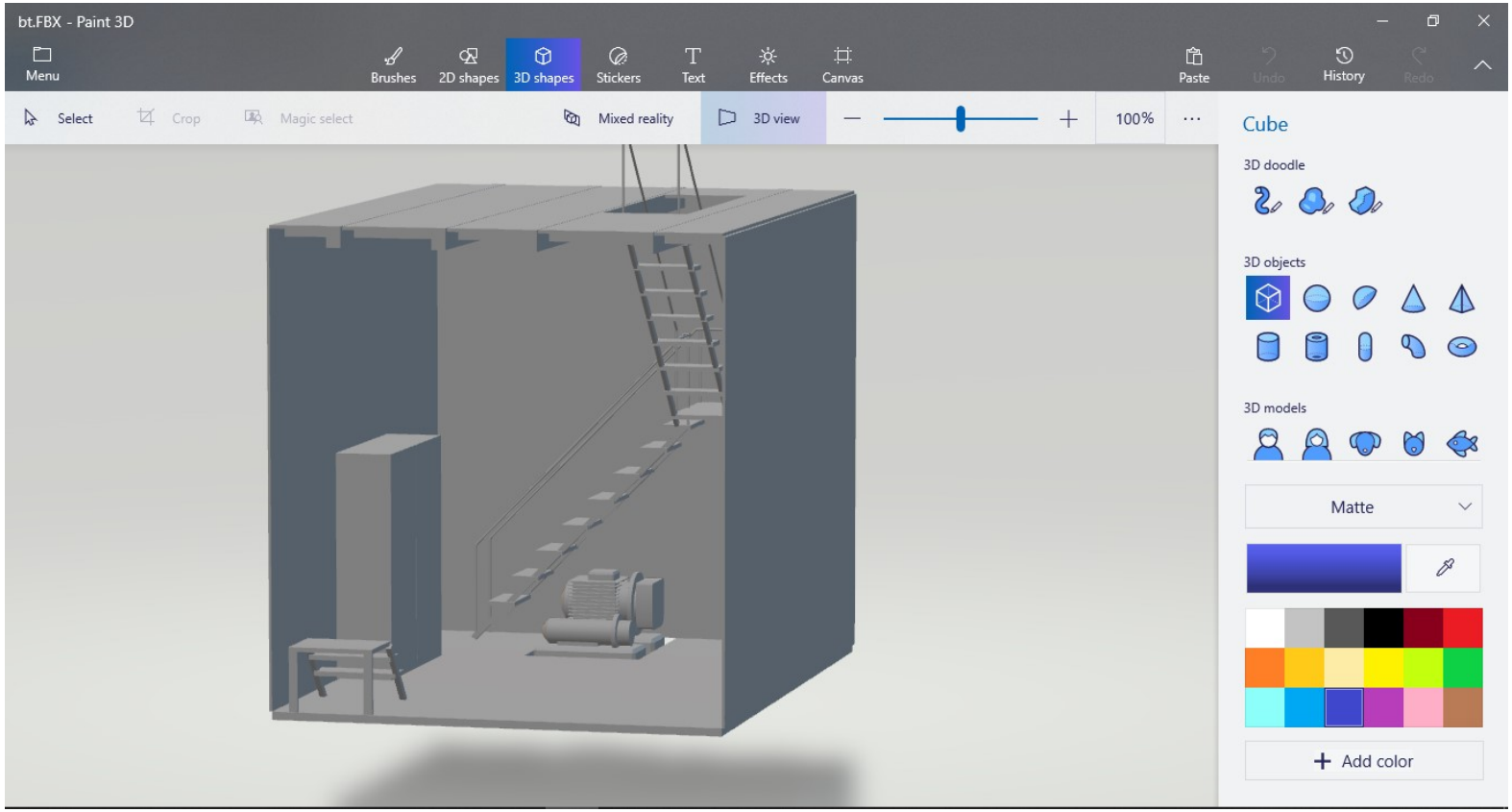

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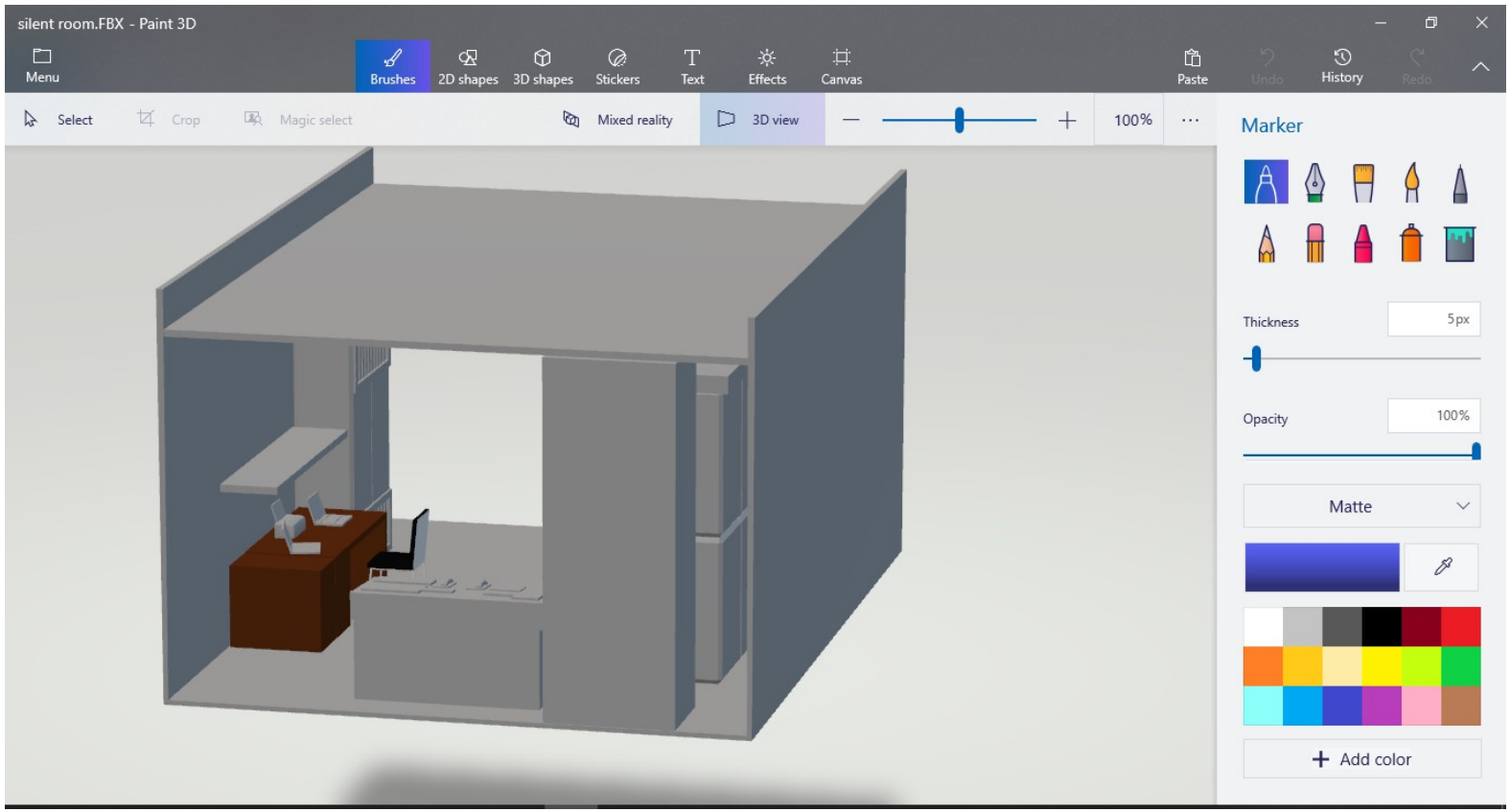

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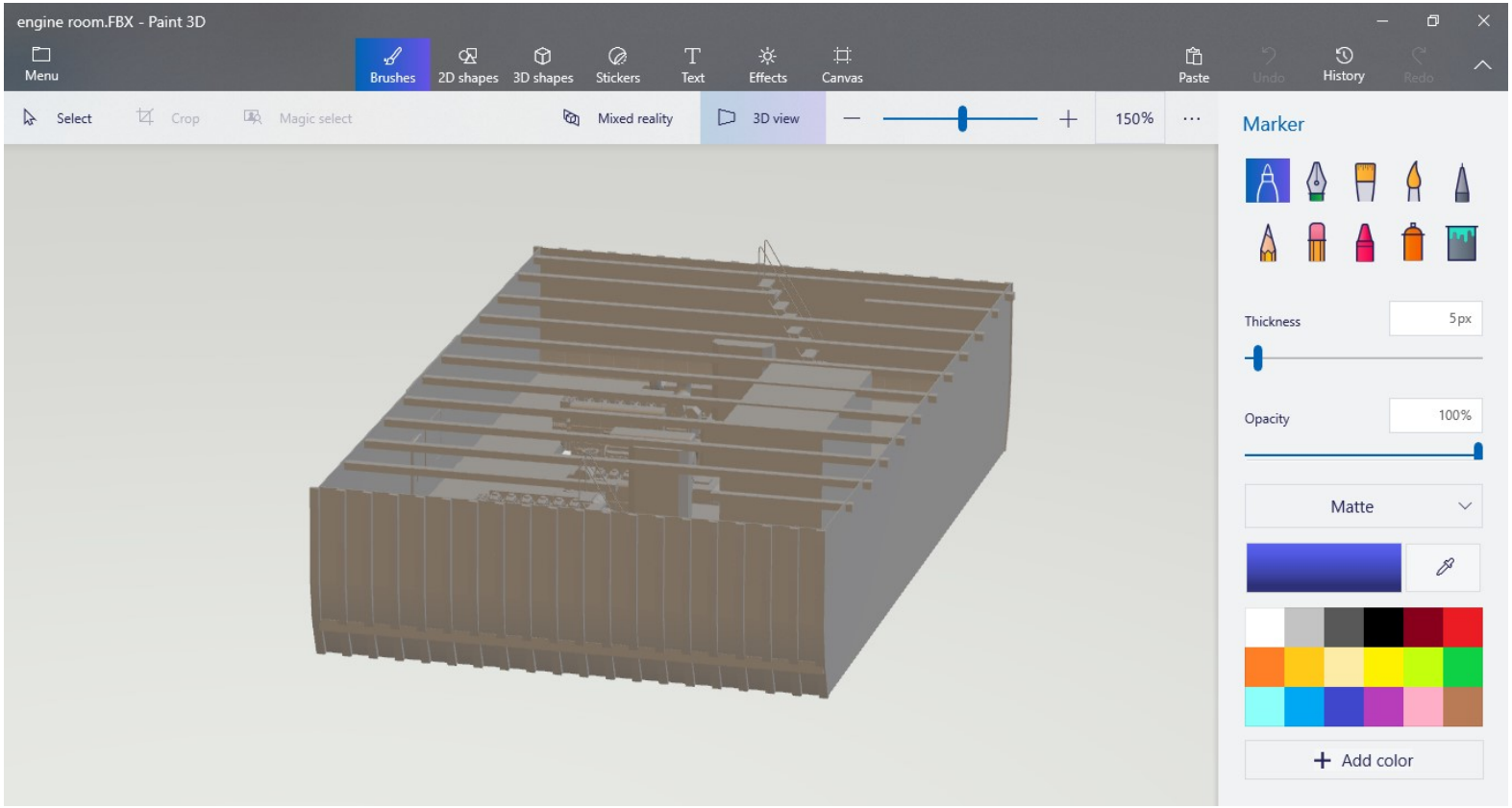

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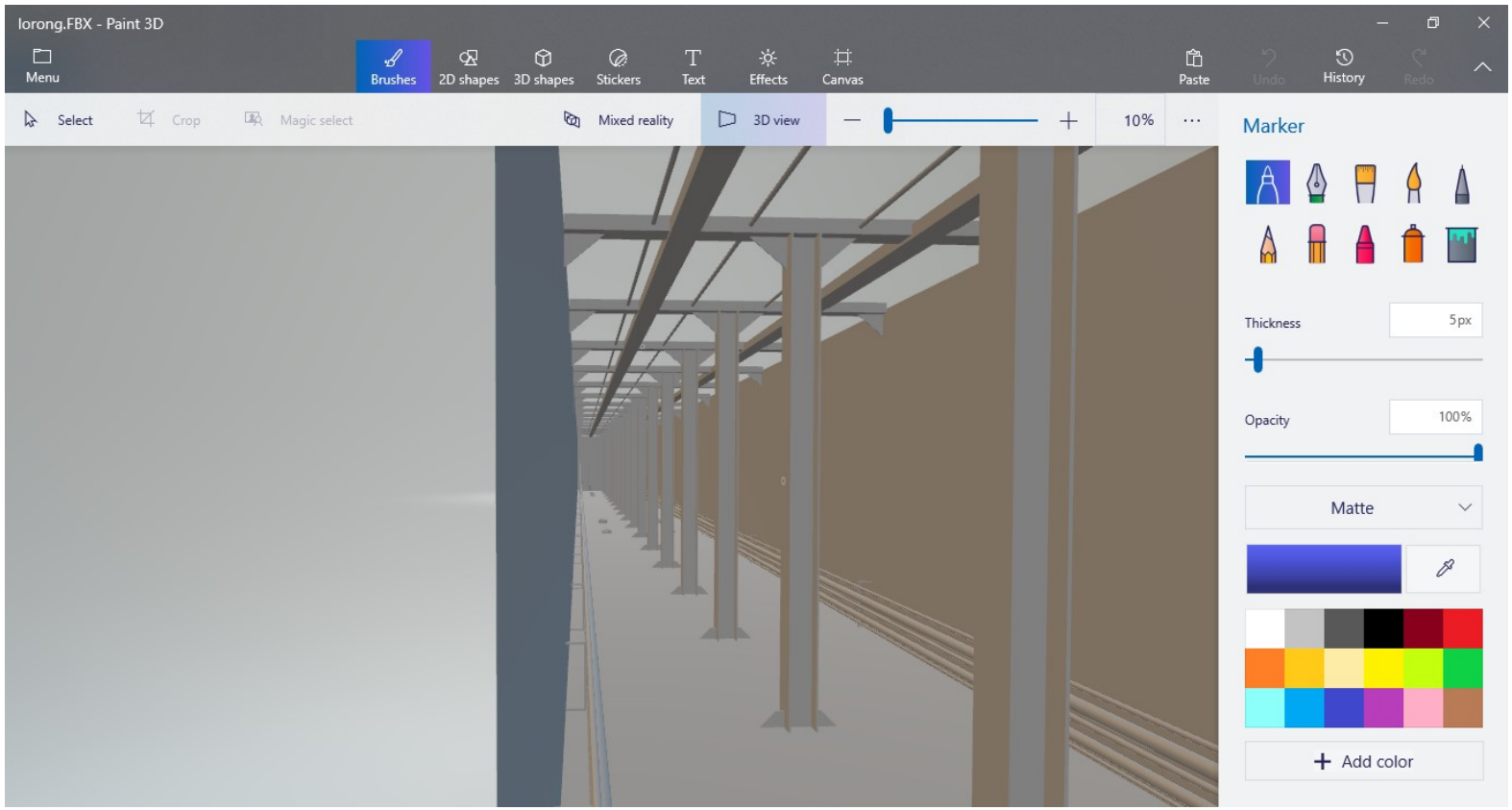

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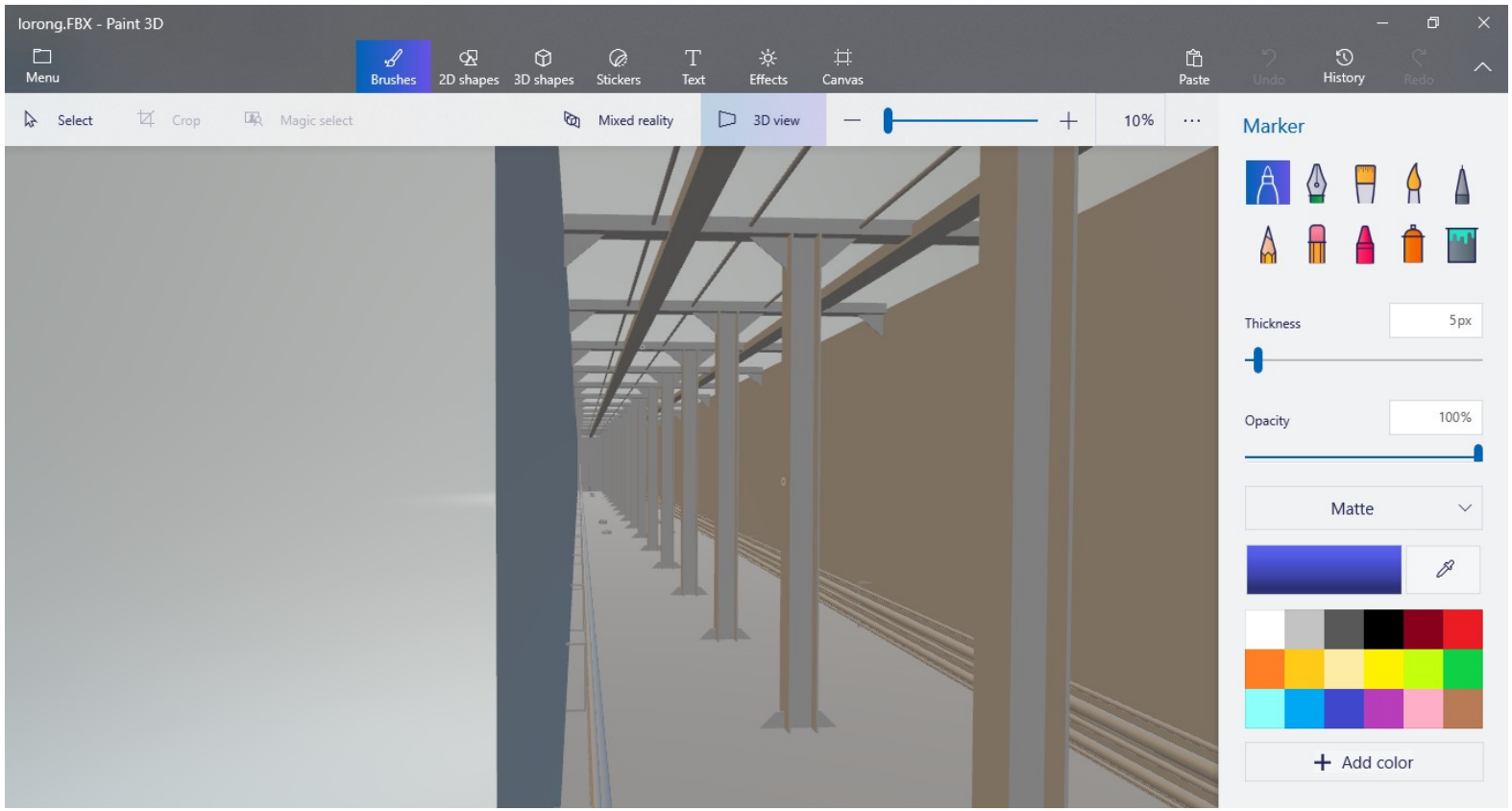

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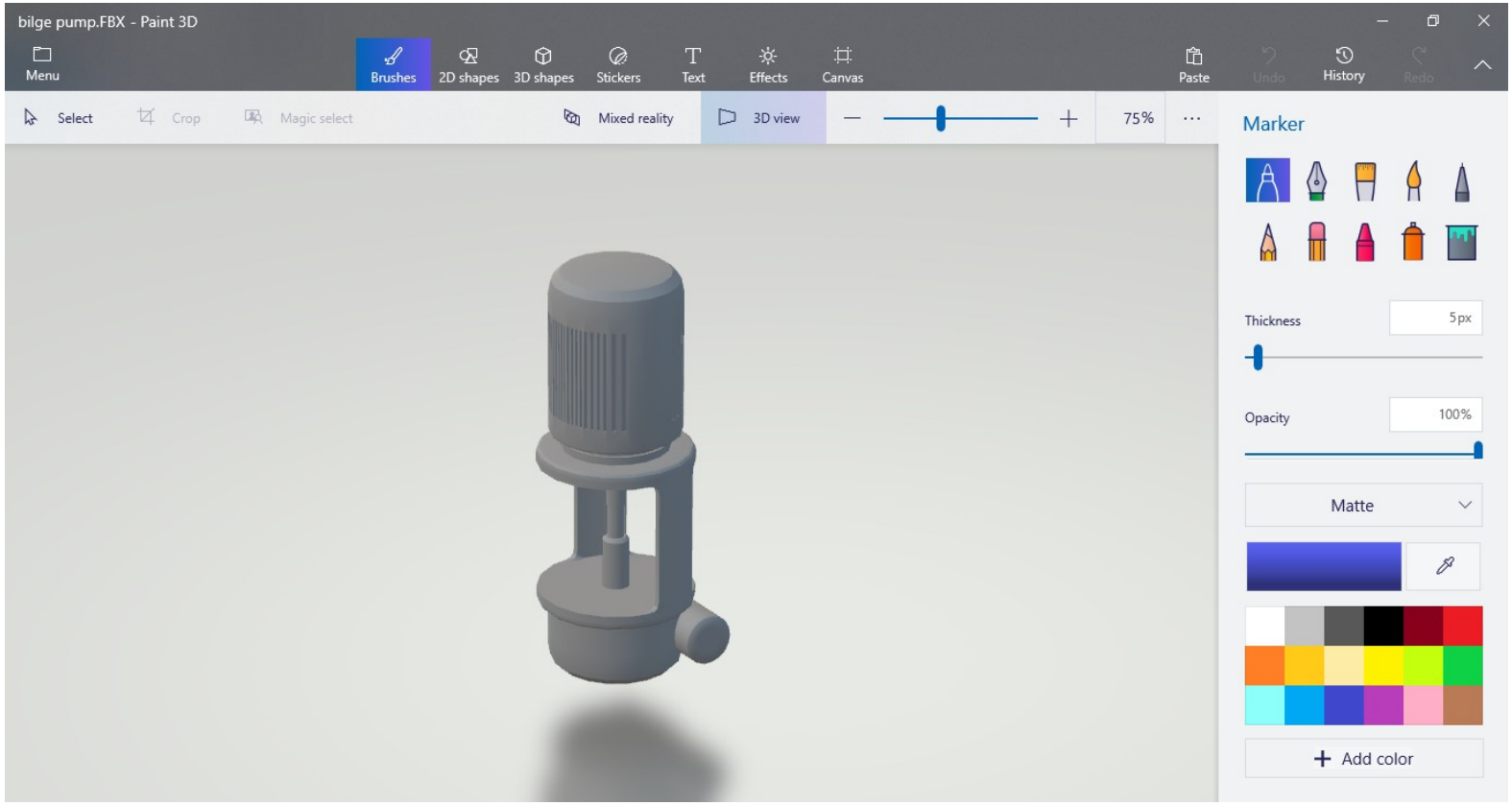

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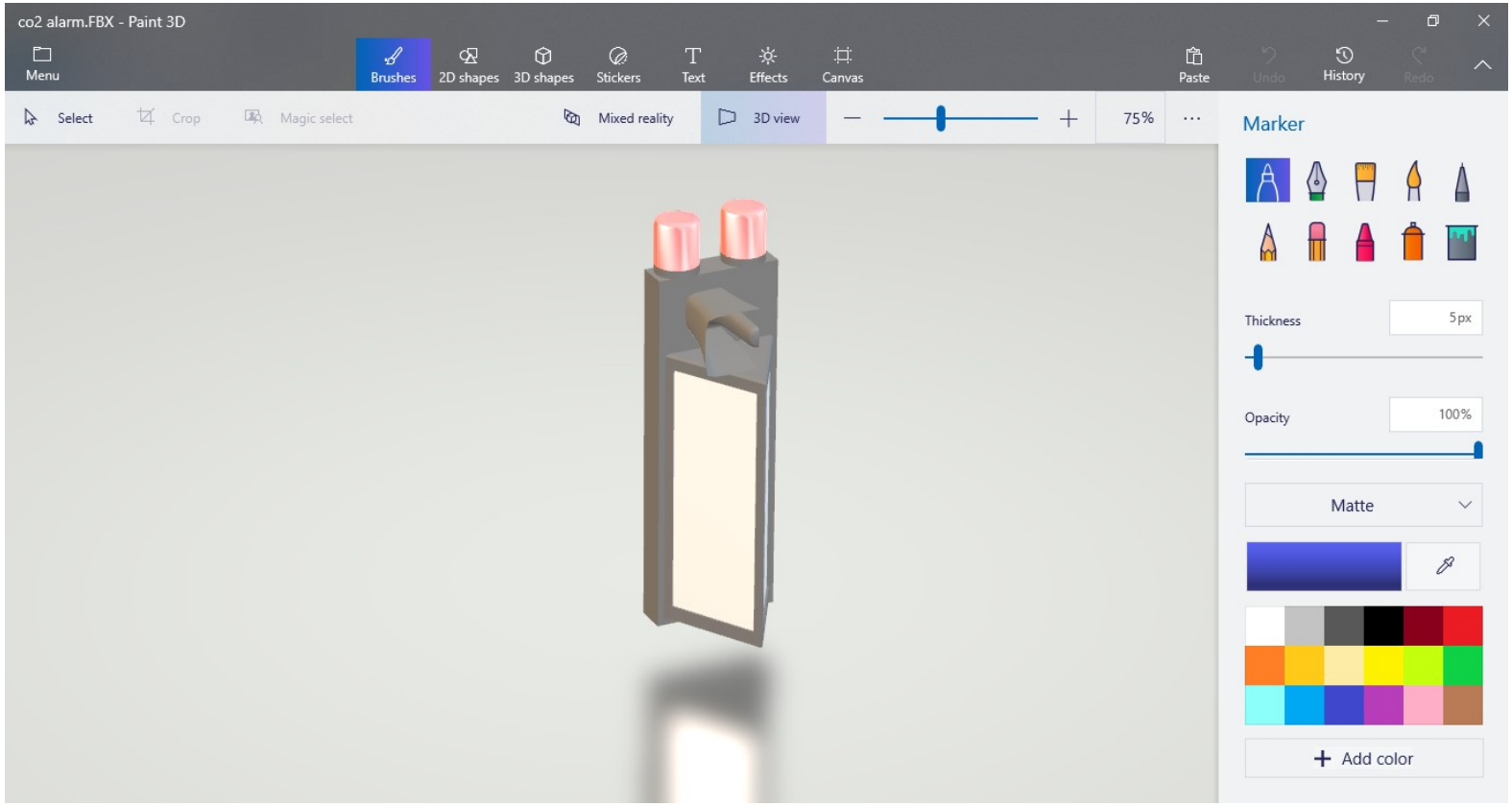

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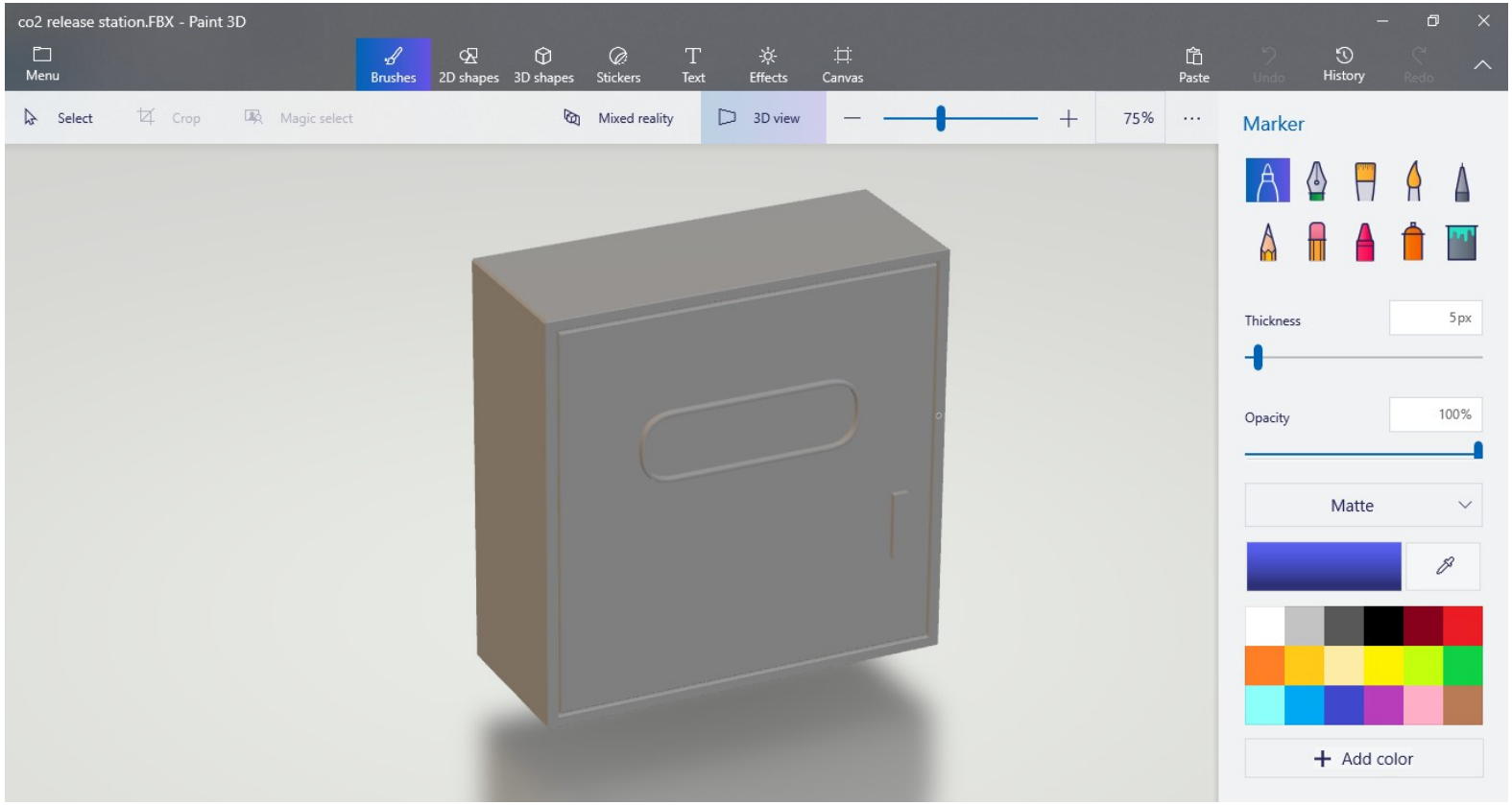

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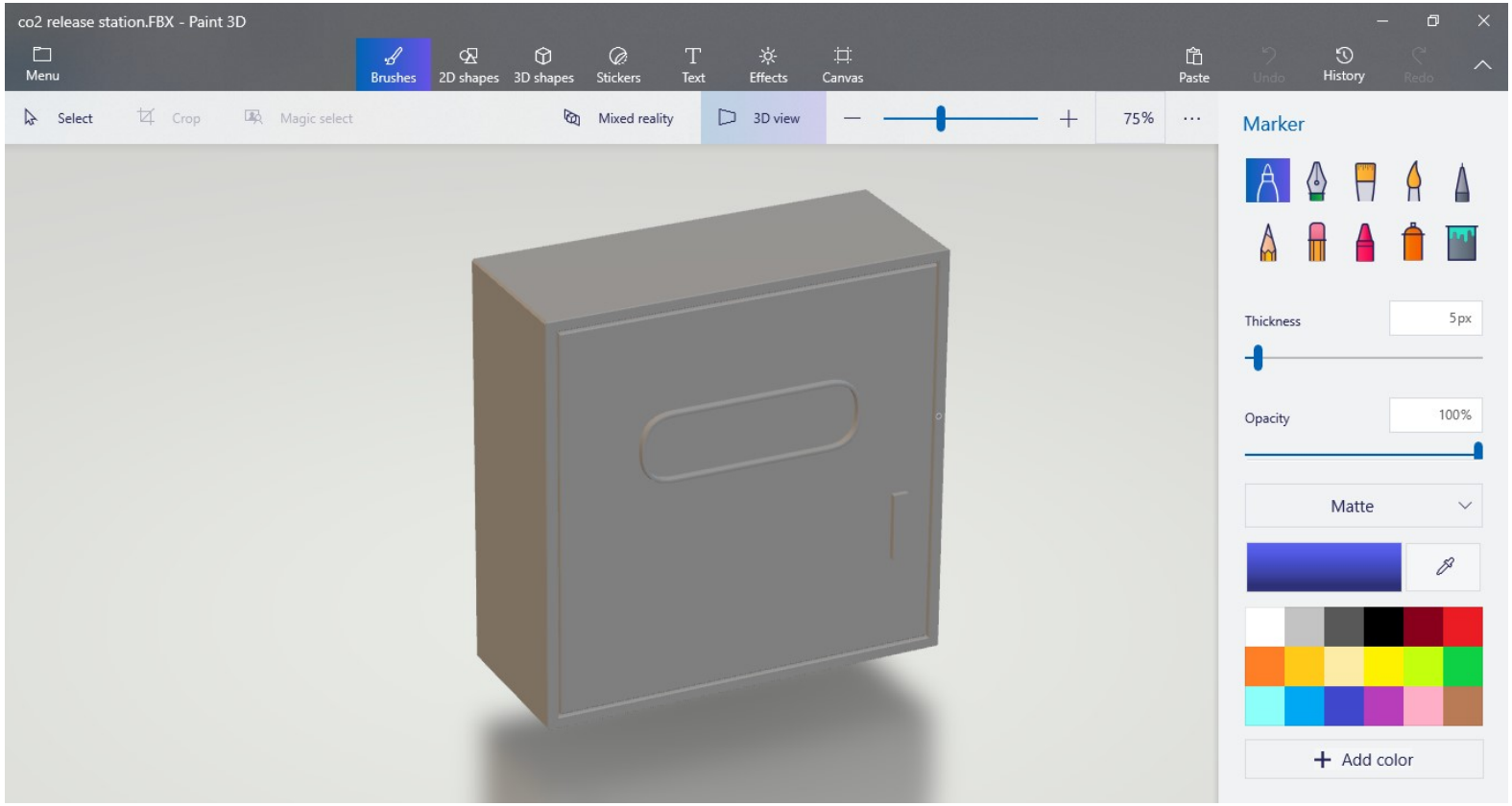

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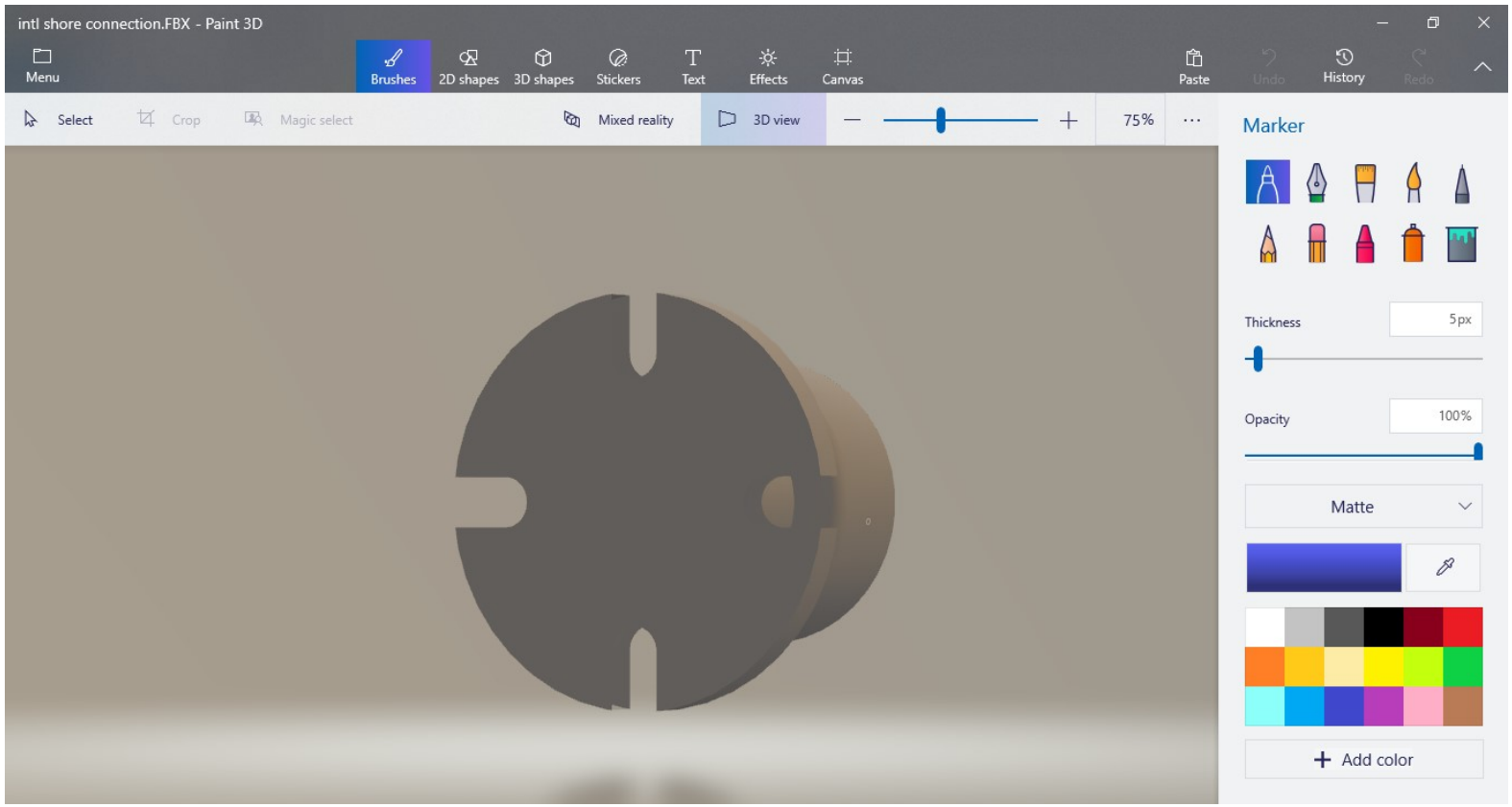

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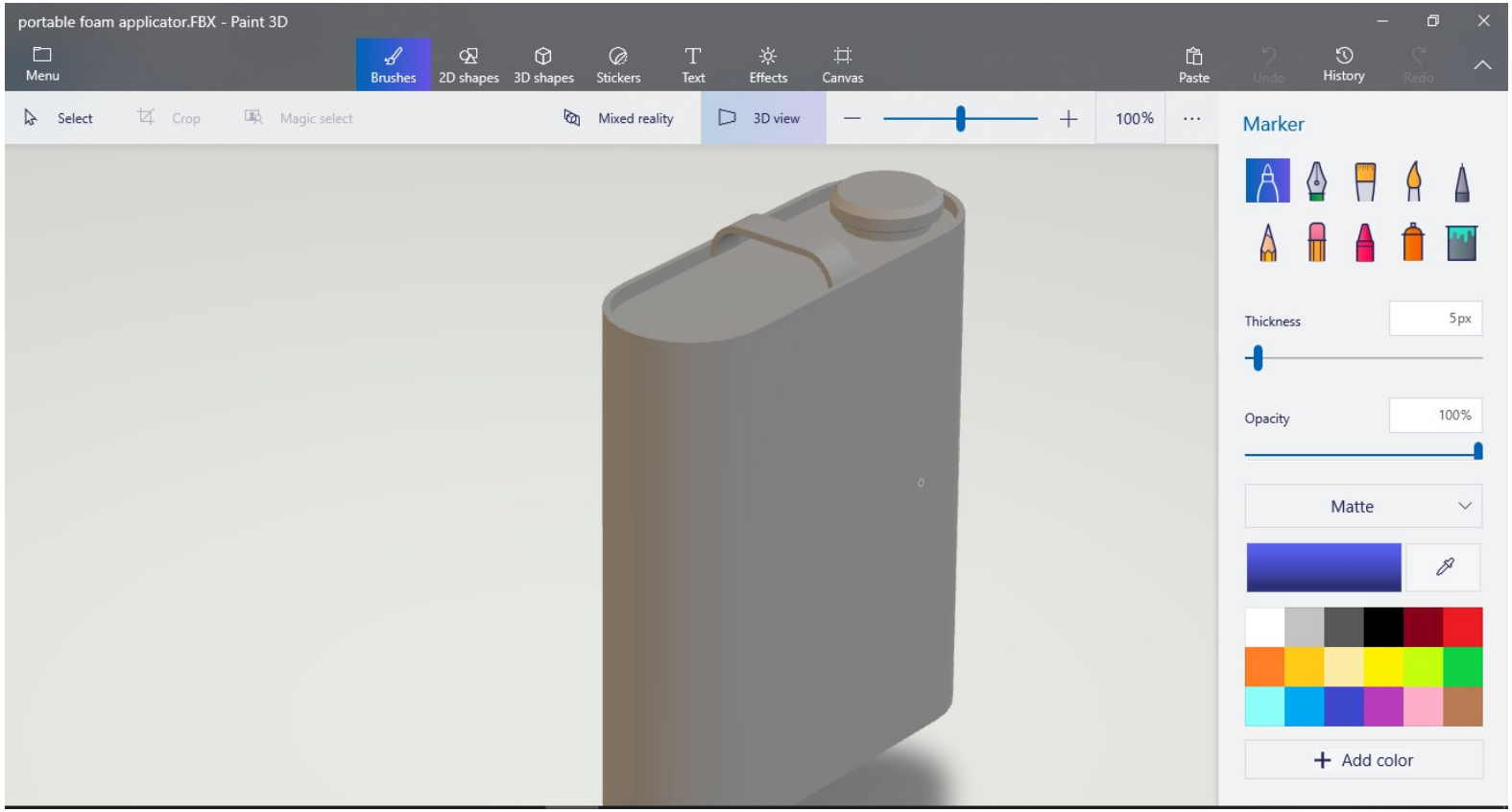

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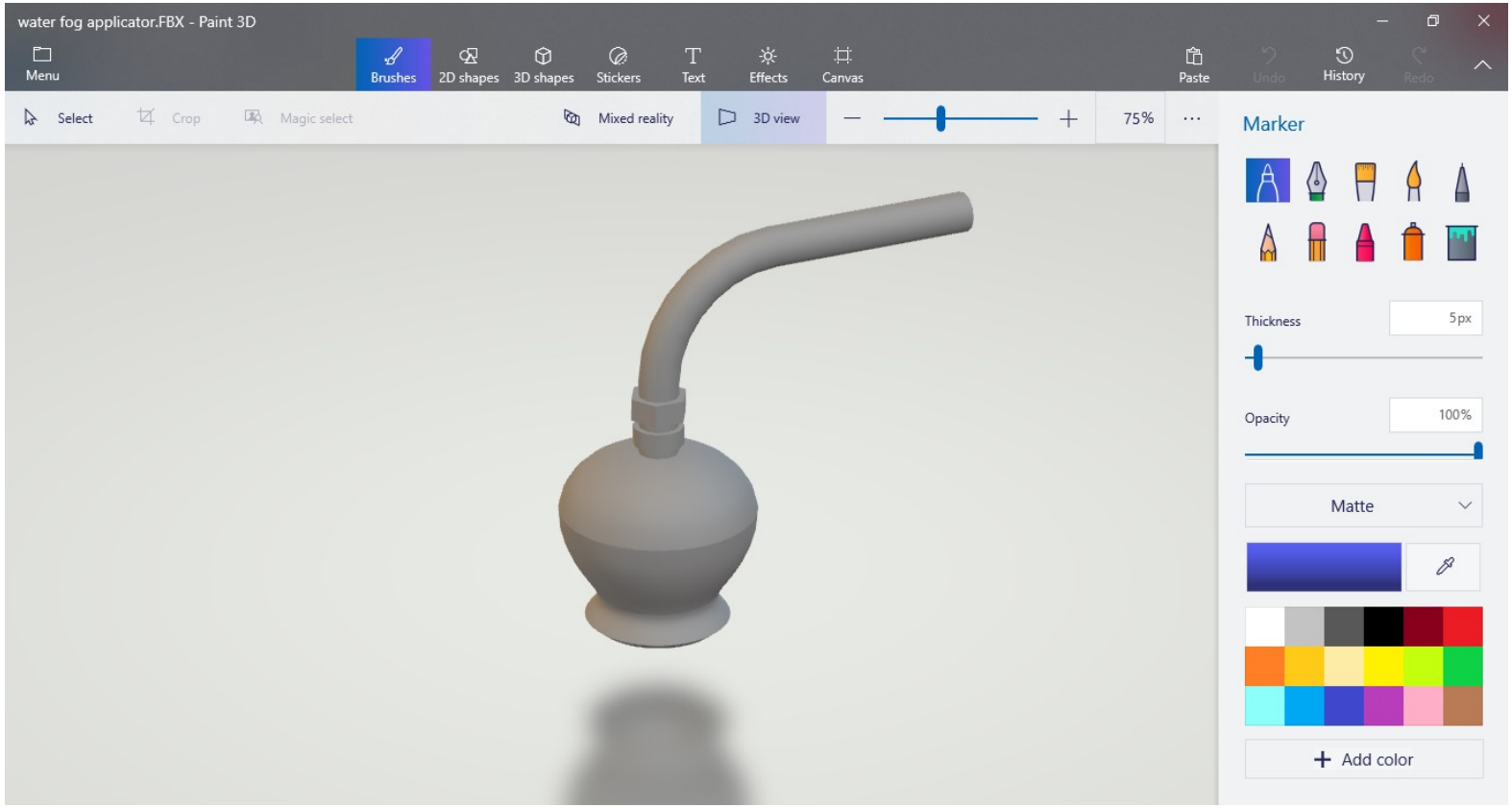

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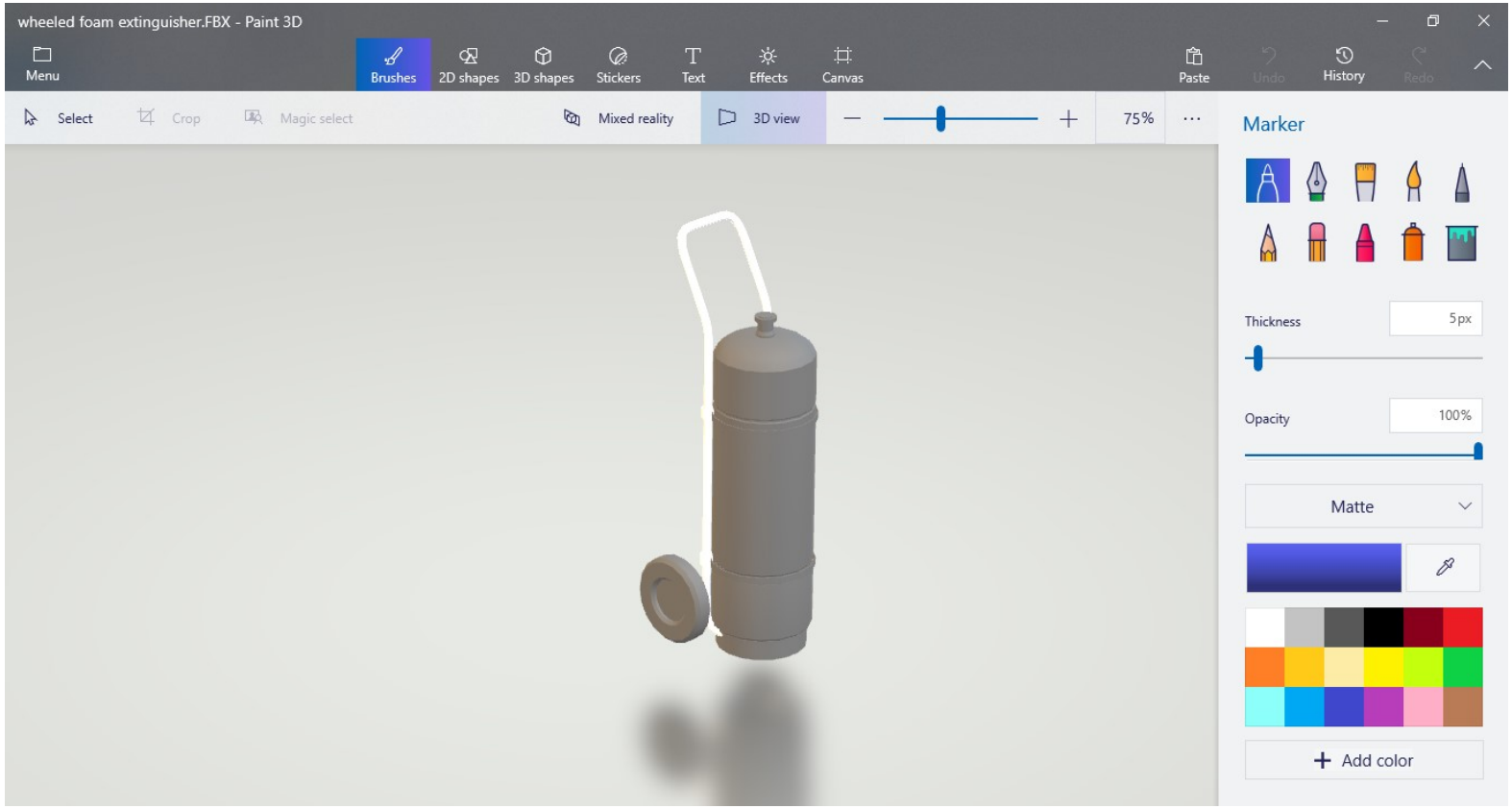

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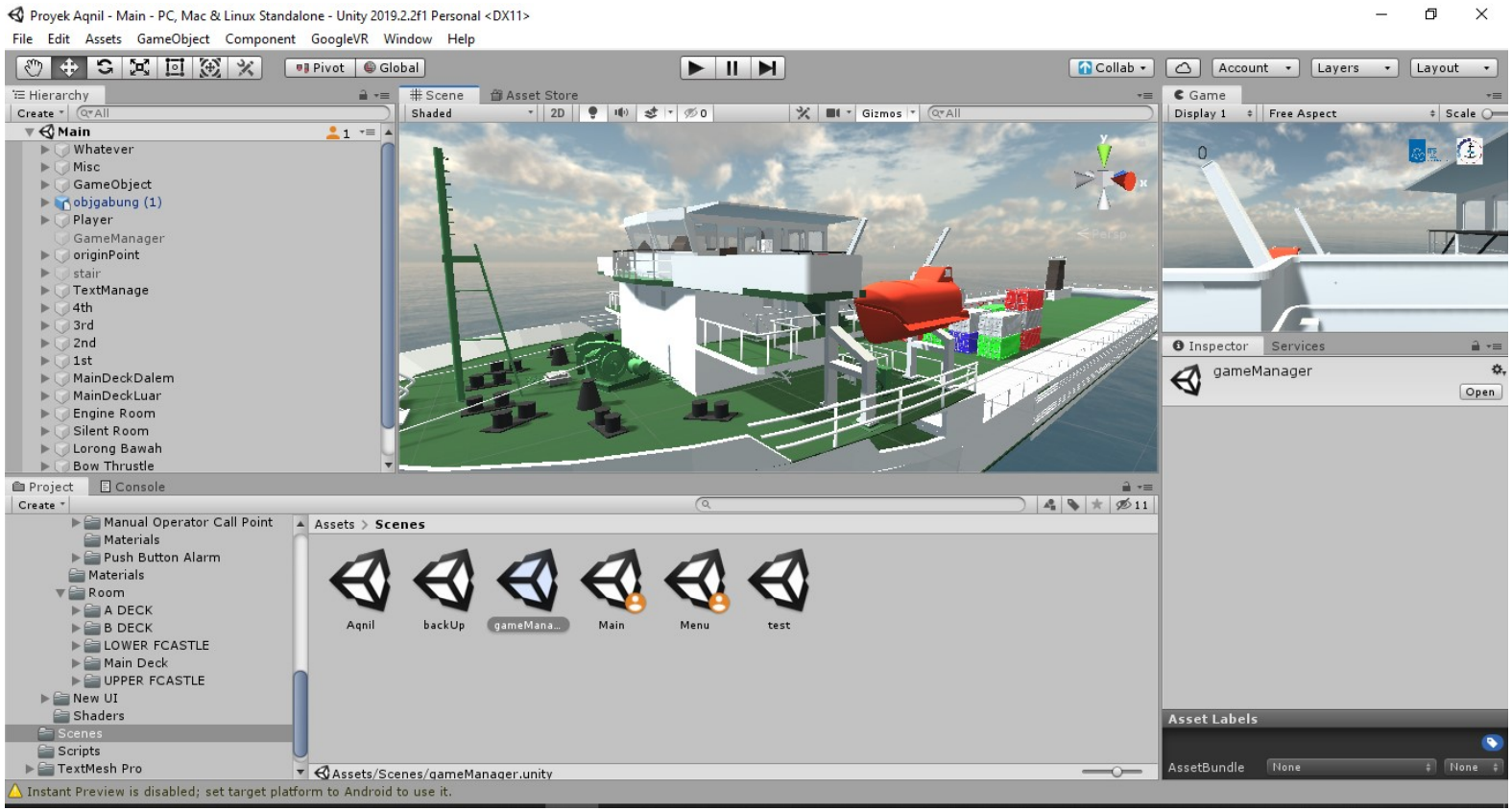

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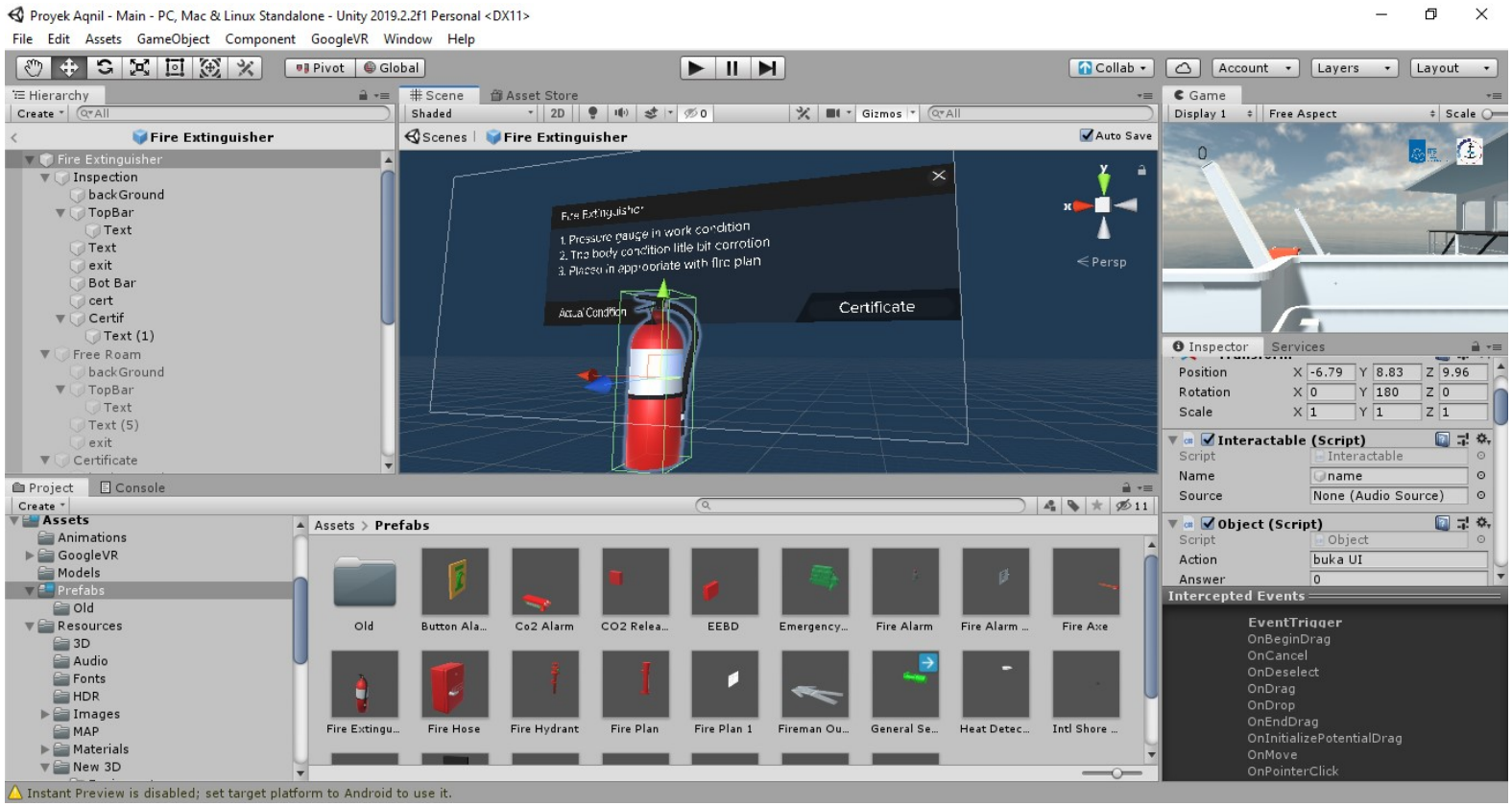

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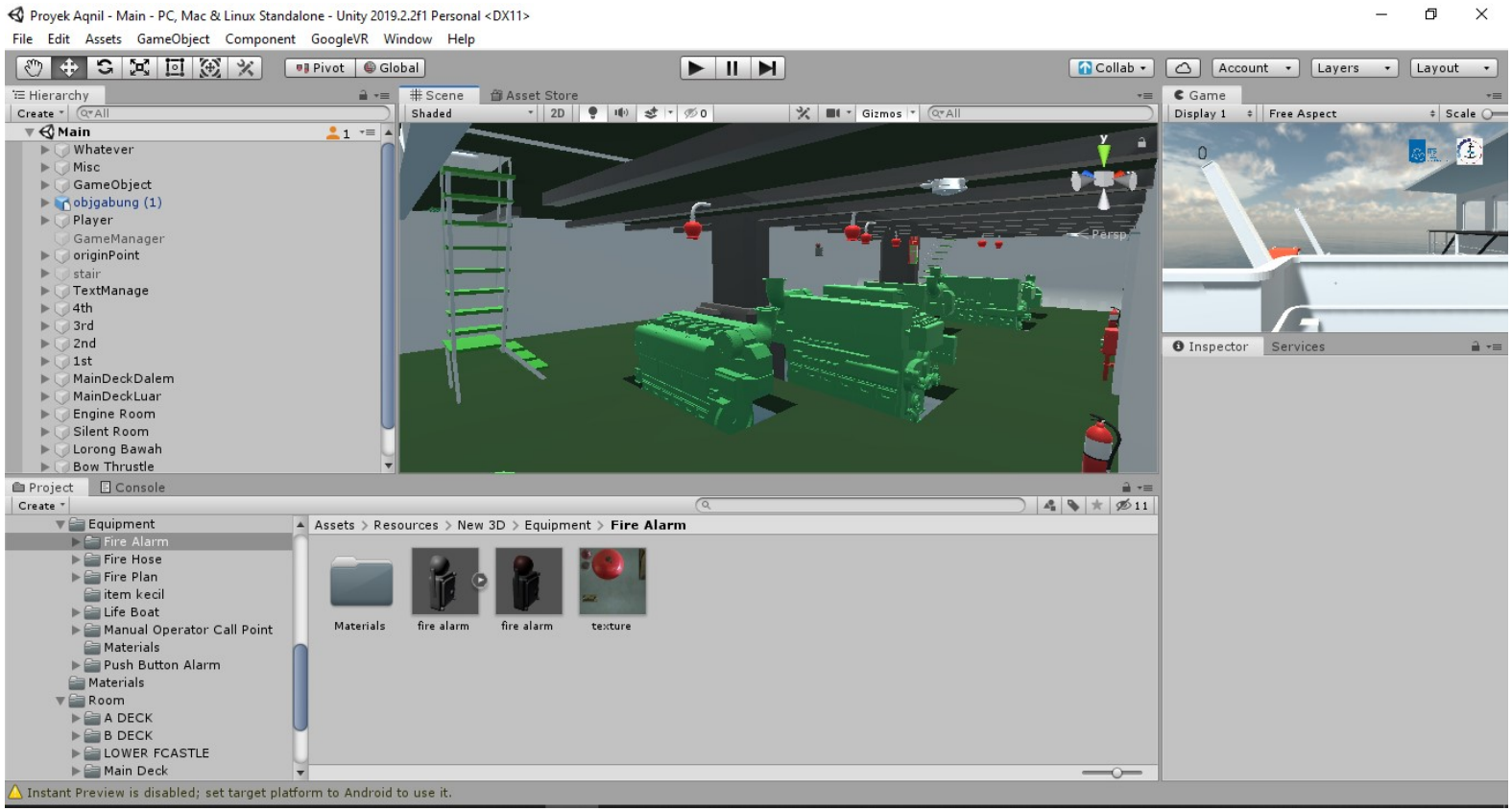

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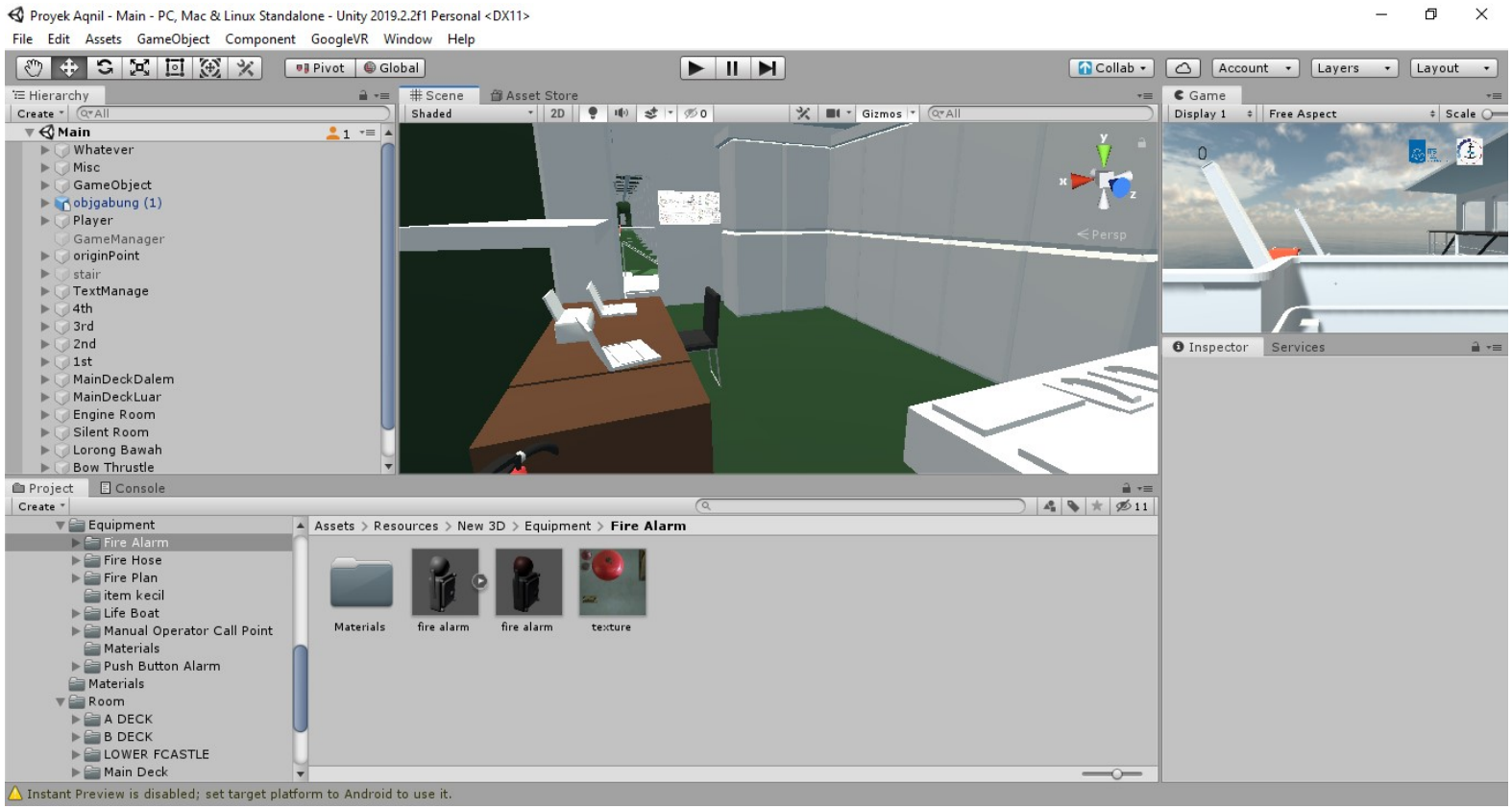

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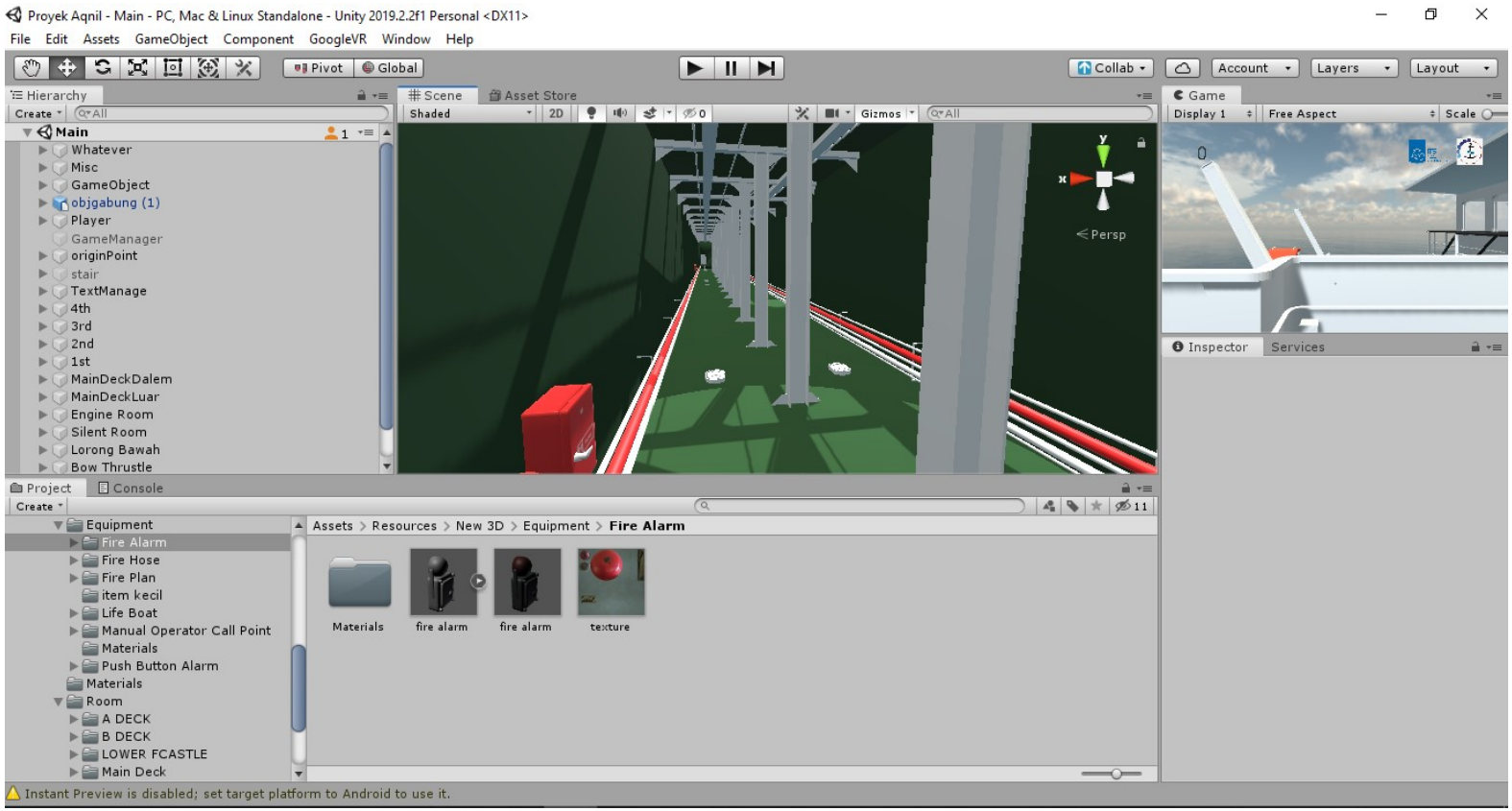

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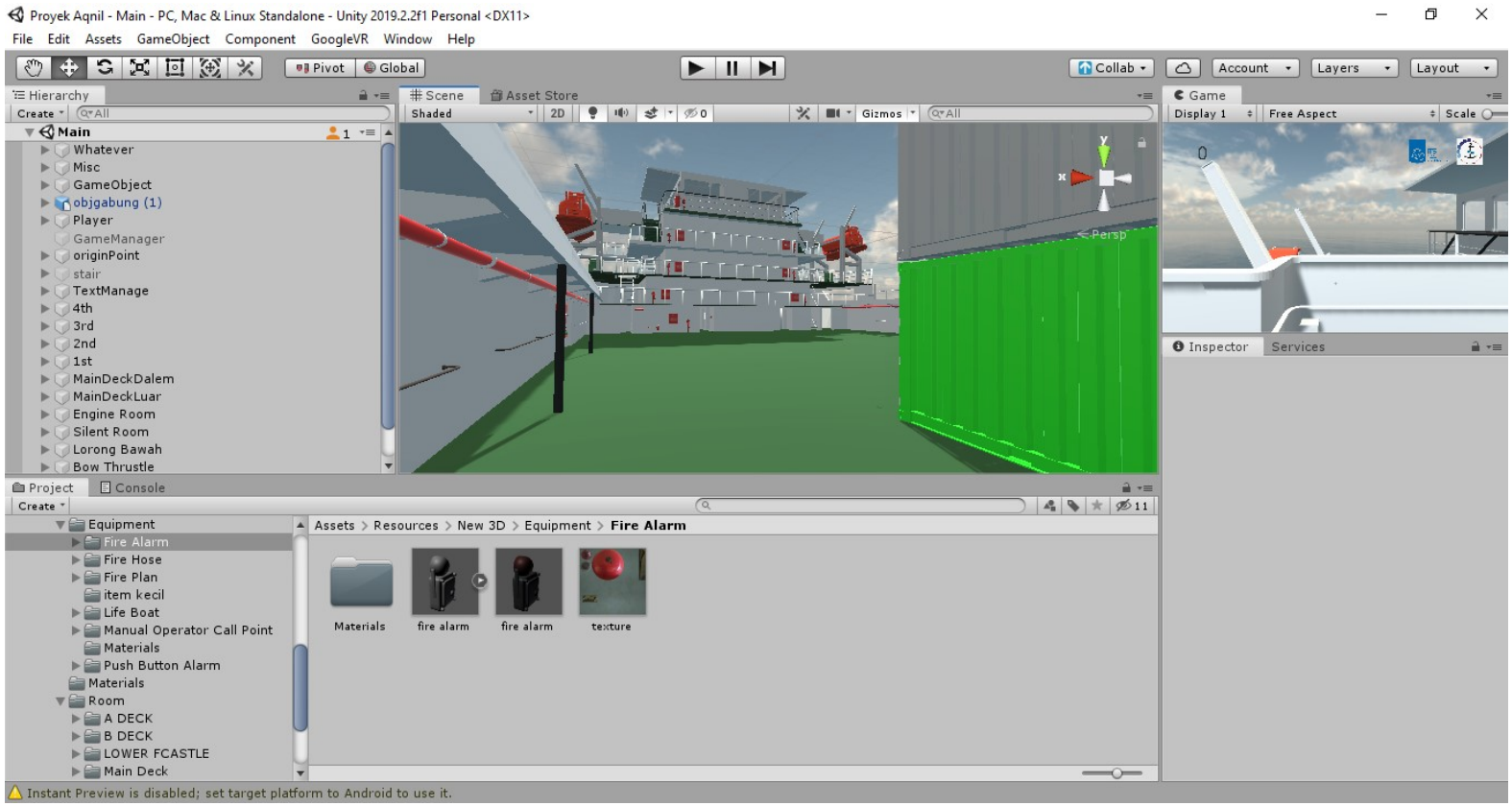
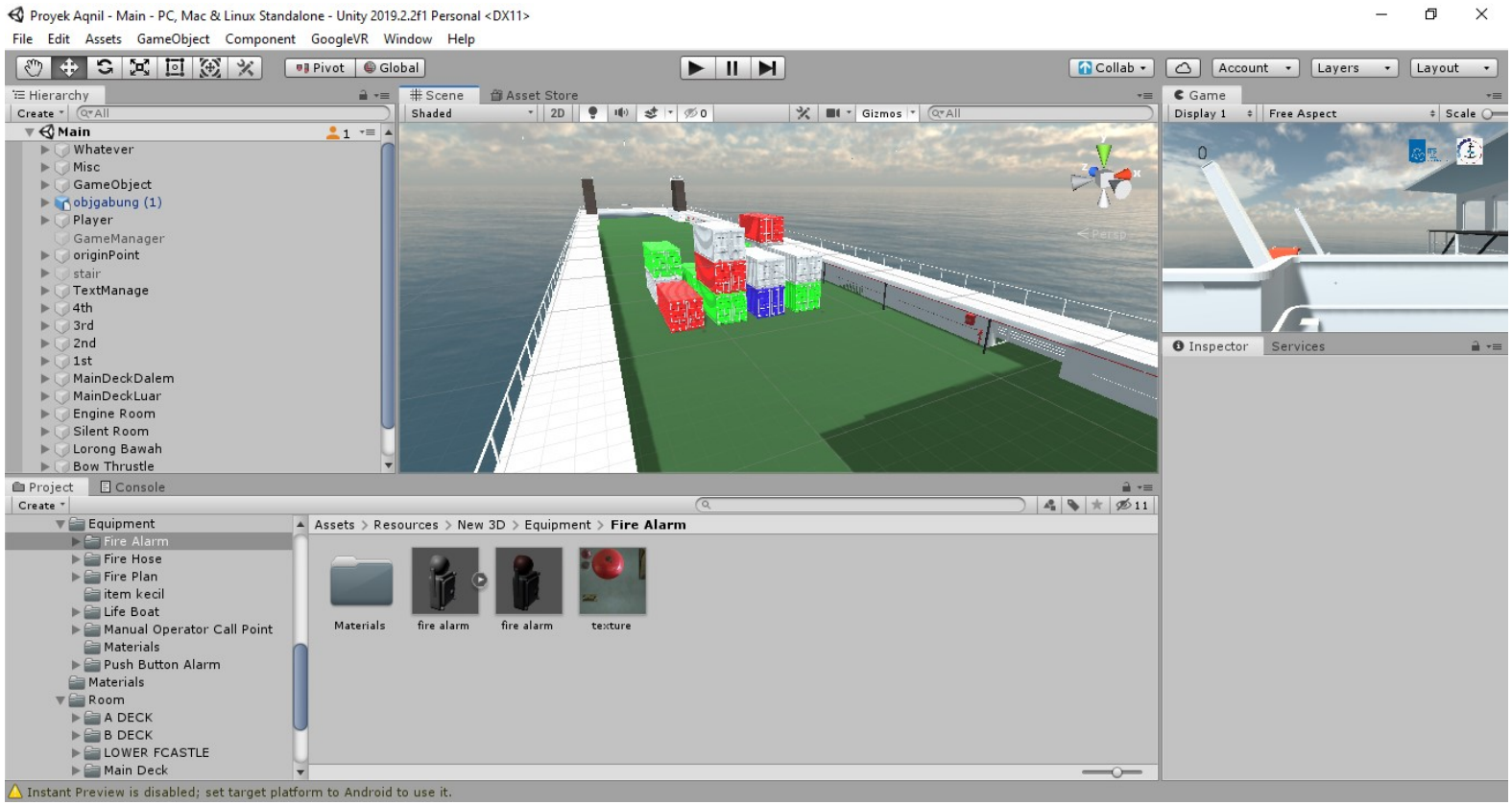


UNITY APPLICATION FOR CREATING VIRTUAL REALITY APPLICATION



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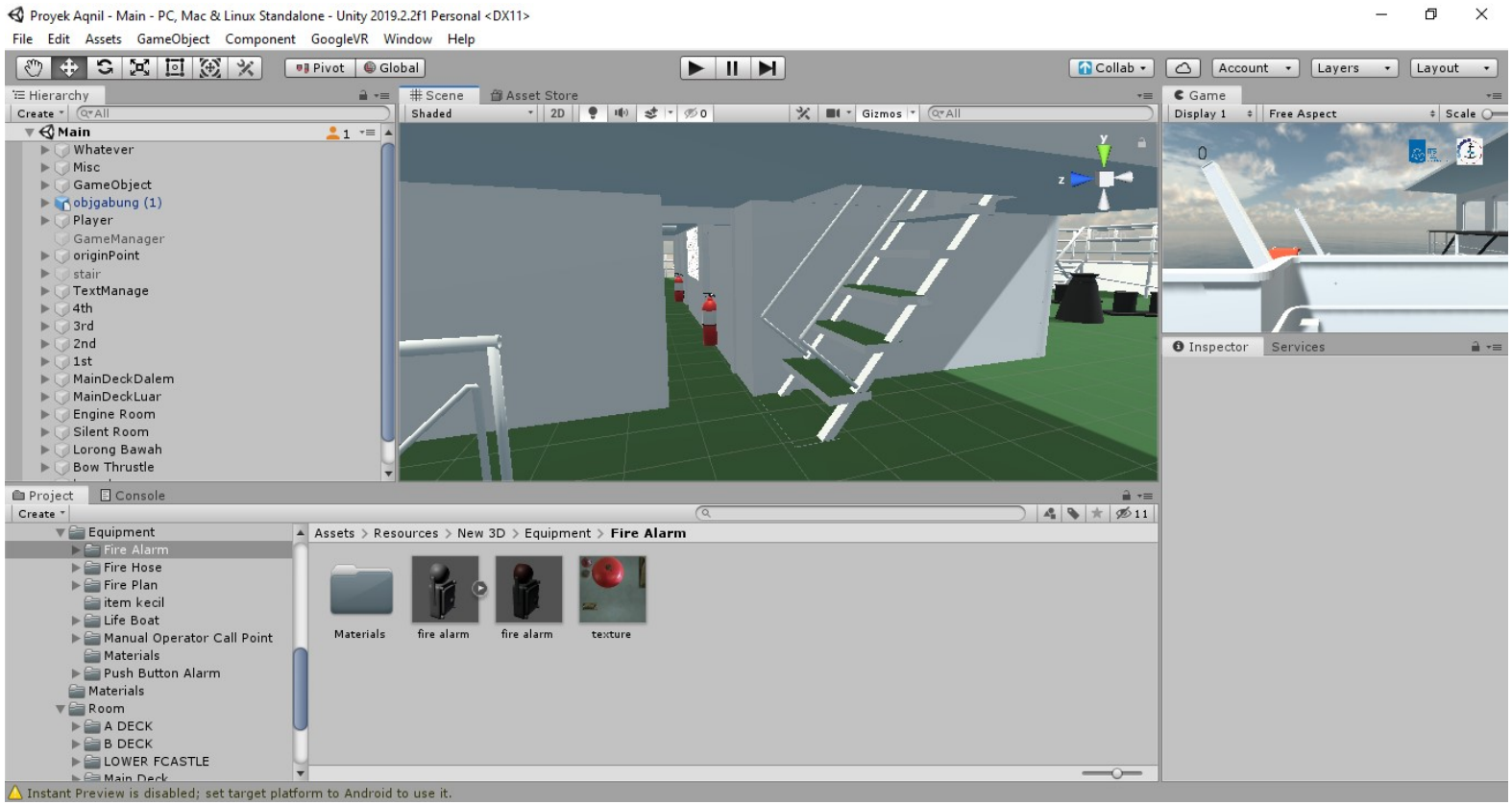

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The author's name is Aqnil Putra Mahdali, born on 18rd March 1998 in Jakarta, Indonesia. Author is the oldest child from 4 siblings. Author is derived from a family with father named Dali Mahdali and mother named Sukamti. The author had formal studies at SDS Plus Hang Tuah V Jakarta (2004-2010), SMPN RSBI 30 Jakarta (2010-2013), and SMAN 13 Jakarta (2013-2016). In 2016, the author went to Surabaya in order to continue the study at Department of Marine Engineering (Double Degree Program with Hochschule Wismar), Faculty of Marine Engineering, Institut Teknologi Sepuluh Nopember Surabaya specialized in Marine Operation and Maintenance. During the study period, the author is a member of MOM Laboratory of Marine Engineering. The author also has work experiences in two companies as engineering student intern e.g., PT. Yasa Wahana Tirta Samudera (2018) in Semarang and PT. Jakarta International Container Terminal (2019) in Jakarta. For further discussion and suggestion regarding to this research, the author can be reached through email and phone number stated as below.

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