

University of Business and Technology in Kosovo

**UBT Knowledge Center**

---

Theses and Dissertations

Student Work

---

Winter 1-2019

## **Presenting a product design from Computer-generated imagery (CGI)**

Mirjeta Mustafa

Follow this and additional works at: <https://knowledgecenter.ubt-uni.net/etd>



Part of the [Computer Sciences Commons](#)

---



Programi për Shkenca Kompjuterike dhe Inxhinierise

**Presenting a product design from Computer-generated imagery (CGI)**

Shkalla Bachelor

Mirjeta Mustafa

Janar 2019

Prishtinë



Programi për Shkenca Kompjuterike dhe Inxhinierise

Punim Diplome

Viti akademik 2015-2016

Mirjeta Mustafa

**Presenting a product design from Computer-generated imagery (CGI)**

MSc. Faton Spahiu

Janar 2019

Ky punim është përpiluar dhe dorëzuar në përmbushjen e kërkesave të  
pjeshme për Shkallën Bachelor

## Abstract

The purpose of this thesis is to determine a solution to overcome photography problems to present product design by using Computer Generated Imagery. CGI and virtual design now play a key role in the development of many materials, processes and products. Through this study has been explored, the impact of 3D render to exhibit the product design, as well as a brief history of photography and how it is used to present the product, the problems that have emerged during the use of photographs to present the product design have been discussed, and how new technologies have enabled us to solve these problems. It is also mentioned what these technologies are, and how they can be used to promote our product design. The main thing in this paper is the 3D model that I've modelled and rendered using 3D Studio Max software, where I also showed step by step how to create it. The principal results of this research are: the positive force of CGI to promote whatever you want, how easy is to use these technologies, you can see your product how it interacts with other elements even if it still not exist in real life.

Keywords: 3D render, Photography, Product design, Computer Generated Imagery.

## Acknowledgments

The completion of this project could not have been accomplished without support, encouragement and advice of Professor Faton Spahiu. I express my sincere appreciation for the learning opportunities and comfortable conditions provided by the University of Business and Technology (UBT).

I cannot express enough thanks to my colleagues and friends as well, Fëllënza, Tedon, Diella and Medina for their support during the studies.

Finally, to my caring, loving and supportive family especially parents, my deepest gratitude for their encouragement and moral support during my studies.

## Table of Contents

<b>Abstract</b> .....	I
<b>Acknowledgments</b> .....	II
<b>Table of figures</b> .....	V
<b>List of abbreviations</b> .....	VI
<b>1 Introduction</b> .....	1
1.1 Objectives.....	2
1.2 Document Structure.....	2
<b>2 Literature Review</b> .....	4
2.1 Photography .....	4
2.1.1 The First Camera.....	4
2.1.2 The First Photograph.....	4
2.1.3 The First Color Photograph.....	5
2.1.4 Photography in product design.....	6
2.2 Computer-Generated Imagery CGI.....	7
2.2.1 It can help with the design process.....	9
2.3 Render .....	9
2.3.1 Types of 3D rendering.....	10
2.3.2 Autodesk 3D Studio Max.....	10
2.3.3 V-Ray Render.....	11
2.3.4 Corona Render.....	12
2.4 Advantages and Disadvantages of photography and 3D rendering.....	14
2.4.1 Advantages of 3D rendering.....	14
2.4.2 Disadvantages of photography .....	16
2.4.3 Advantages of photography .....	17
2.4.4 Disadvantages of 3D rendering .....	17
2.5 Why IKEA left photography for 3D rendering .....	18
2.5.1 How IKEA is using Virtual Reality .....	21
2.5.2 How IKEA is using Augmented Reality .....	23
<b>3 Problem Statement</b> .....	25
3.1 Research Questions .....	25

<b>4 Methodology</b> .....	26
<b>5 Case study</b> .....	27
5.1 Modelling .....	27
5.2 Texture .....	27
5.3 Colors .....	29
5.4 Light .....	30
5.5 Camera .....	31
<b>5 Results</b> .....	32
<b>7 Conclusion</b> .....	38
<b>References</b> .....	39

## Table of figures

Figure 1 The first photograph that was taken by a camera .....	5
Figure 2 The first durable colour photograph .....	6
Figure 3 Furniture Photography. Left: before retouching. Right: after retouching.....	7
Figure 4 Render Setup Dialog V-Ray .....	12
Figure 5 Render Setup window Corona .....	13
Figure 6 "Bertil" Chair, First IKEA 3D rendering .....	19
Figure 7 A digitally created kitchen scene by IKEA.....	20
Figure 8 IKEA Virtual Reality Showroom.....	22
Figure 9 IKEA using Augmented Reality .....	23
Figure 10 A screenshot of the workflow .....	27
Figure 11 Wood Planks Shaw Classic Hickory Floor Texture.....	28
Figure 12 Rovere Chiaro Shelf Texture .....	28
Figure 13 Color Selector: Diffuse .....	29
Figure 14 V-Ray Light .....	30
Figure 15 The VrayPhysicalCamera .....	31
Figure 16 First Render .....	32
Figure 17 Second Render .....	33
Figure 18 Third Render.....	34
Figure 19 Fourth Render .....	35
Figure 20 Fifth Render .....	36
Figure 21 Day time and Night time.....	37



## List of abbreviations

**CAD** - Computer Aided Design

**CGI** – Computer Generated Imagery

**VR** - Virtual Reality

**AR** – Augmented Reality

**CG** - Computer Graphics

**CLI** – Command Line Interface

**CPU** - Central Processing Unit

**UHD** – Ultra High Definition

**BDPT/VCM** – Bidirectional Path Tracing/Vertex Connection and Merging

**UI** – User Interface

# 1 Introduction

The rapid development of computer graphics technologies has made it easier to generate photorealistic computer graphics, and these graphics are quite difficult to distinguish from natural images by our naked eyes. The creation of new products is one of the key drivers of consumer society. These products are created through the process of product design. At its basis, therefore, product design refers to all the work done up to the point when the new product is in the consumer's hands or on their screen.

As such, product design involves a number of complex activities. It involves identifying a problem users experience and generating a solution. However, it also encompasses every aspect of the new product, the processes used to create it, its style, the materials used, its mechanical architecture, and more. Quite simply, it's about creating a product that works.

The thesis goes through the history of photography and how it is used to promote product design, continuing with what is CGI and 3D modelling and rendering, it also includes how the largest and most successful furniture company IKEA started to use 3D rendering instead of photography. Going on with the problems that happen in photo-shoot, and how the new technologies help us to pass those problems. Furthermore, we designed a 3D model which is explained step by step in the case study chapter using 3D Studio Max software, and render form of the model it has been done with the Corona render in the results chapter.

3D rendering is one of the fastest-growing industries on the planet. 3D rendering is art itself but at the same time, it is the best possible visual communication for the conceptualized product design. 3D modelling is the process of using software to create a mathematical representation of a 3-dimensional object or shape. The created object is called a 3D model and these 3-dimensional models are used in a variety of industries. [1]

3D rendering software is the process of generating an image from a model by means of computer software. Rendering is used in architecture, simulators, video games, films and television visual effects and design visualization. 3D rendering, the last step in an animation process, gives the final appearance to the models and animation with visual effects such as shading, texture-mapping, shadows, reflections and motion blurs. [1]

## 1.1 Objectives

The purpose of this thesis is to find a solution to reduce photography problems to present product design by using available technologies:

1. Computer modelling and simulations allow designers to test designs for functionality before investing in tool up for production.
2. The use of CAD software allows products to be designed and manufactured more quickly and accurately.

## 1.2 Document Structure

The thesis consist of seven chapters:

### **Chapter 1: Introduction**

This chapter gives a brief overview about product design and is divided in two subchapters, Objectives where gives clarifications to reader about the main goals of thesis and Document Structure which introduces study organization.

### **Chapter 2: Literature Review**

The chapter of literature review gives an overview of Photography, Computer generated imagery, Render, and pros, cons for render and photography.

### **Chapter 3: Problem Statement**

This chapter covers the photography limitations and the problem declaration, here are included also two search question.

### **Chapter 4: Methodology**

This chapter includes activities and steps we had to follow up in order to reach our objectives and to get an answer to our research questions.

### **Chapter 5: Case Study**

This chapter presents step by step how to create a photorealistic CGI.

### **Chapter 6: Results**

This chapter contains the rendered form of our product design.

## **Chapter 7: Conclusion**

The last chapter gives very descriptive and briefly tells where you can read the answers for research questions.

## 2 Literature Review

### 2.1 Photography

The word photography comes from the Greek and means “light writing”, the photo is light and graph is writing. The modern scientific understanding of light evolved along with the development of the camera and photography, making photography a unique art form that has always been inseparable from science. [2] Photography has been a medium of limitless possibilities since it was originally invented in the early 1800s. The use of cameras has allowed us to capture historical moments and reshape the way we see ourselves and the world around us. [3] The story of photography is fascinating and it’s possible to go into great detail. As part of this thesis, let’s take a brief look at the highlights and major development of photography.

#### 2.1.1 The First Camera

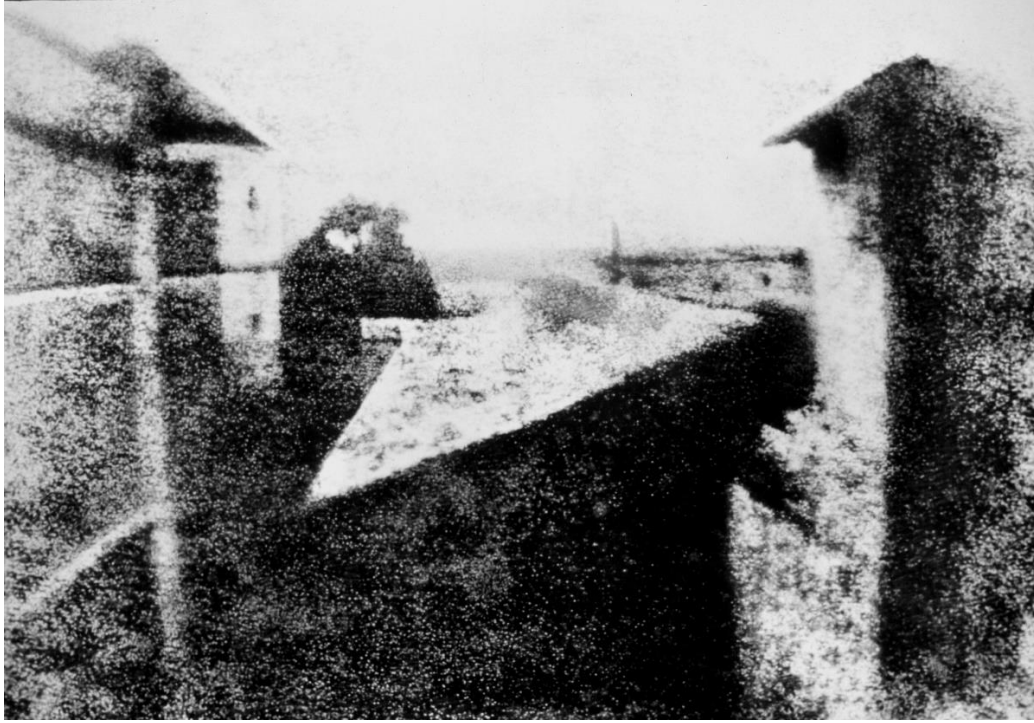
The photographic camera was based on Camera Obscura or pinhole camera (darkroom), which was one of the first discoveries that made photography possible. In it’s earliest form it was simply a darkened box with a tiny hole in one wall and a white screen on the opposite wall. An upside-down imaged of the objects outside the room was formed on the screen by light coming from the hole. The image was upside down due to the way in which light enters the box. Pinhole photography is lensless photography, a tiny hole replaces the lens. Light passes through the hole, an image is formed in the camera. Basically a pinhole camera is a box, with a tiny hole at one end and film or photographic paper at the other. [4]

#### 2.1.2 The First Photograph

The world’s first photograph made in a camera was taken in 1826 by Joseph Nicéphore Niépce. The photograph was taken from the upstairs’ windows of Niépce’s estate in the Burgundy region of France. This image was captured via a process known as heliography, which used Bitumen of Judea<sup>1</sup> coated onto a piece of glass or metal, the Bitumen than hardened in proportion to the amount of light that hit it. [3]

---

<sup>1</sup> Bitumen of Judea, Natural asphalt with photoresist properties. It is the light-sensitive material capable of producing durable light-fast results. [28]



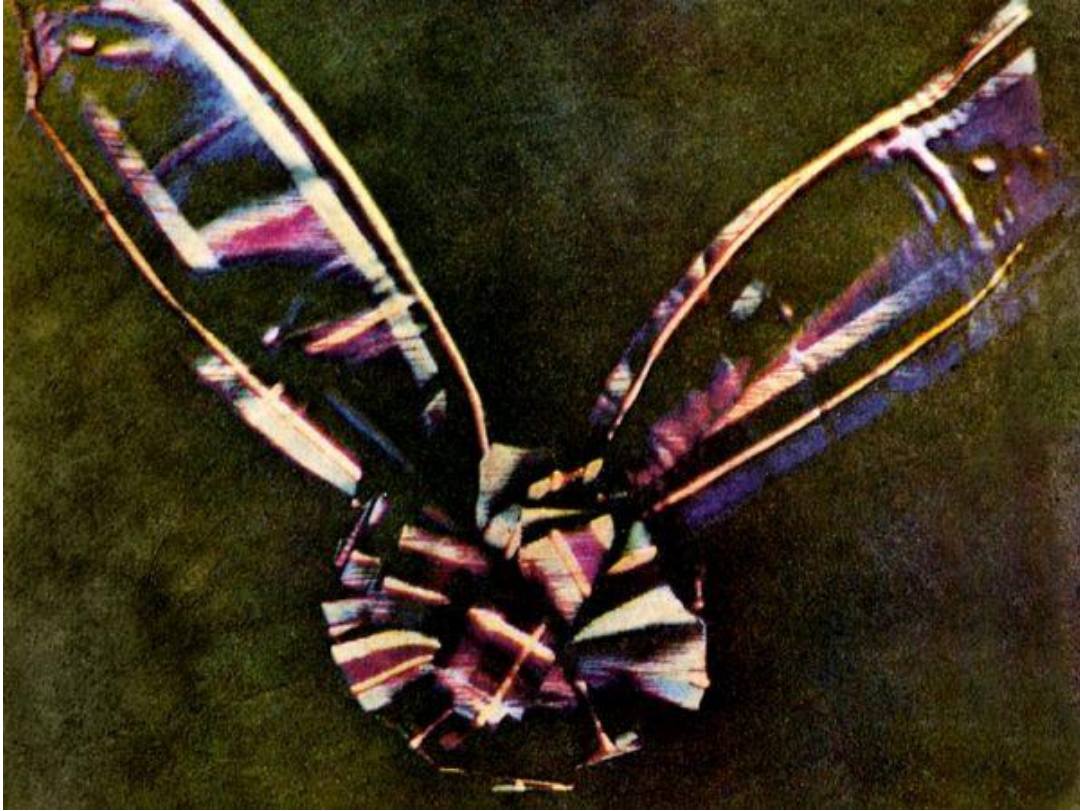
*Figure 1 The first photograph that was taken by a camera*

### 2.1.3 The First Color Photograph

The first ever known photograph was taken by Joseph Nicéphore Niépce in 1826, as I mentioned above, but it took until 1861 for someone to develop the technology to incorporate very the basic colour. It was Scottish physicist and poet James Clerk Maxwell who produced the first true colour photograph, one that didn't fade immediately or need colour adding afterwards by hand. The image is of tartan ribbon<sup>2</sup> and it was photographed three times using different coloured filters red, blue and yellow. The three images were then overlaid to create a single composite. The technique was developed according to theories about how the eye processes colour. [5]

---

<sup>2</sup> Tartan ribbon, a woollen cloth woven in one of several patterns of coloured checks and intersecting lines, especially of a design associated with a particular Scottish clan. [29]



*Figure 2 The first durable colour photograph*

#### 2.1.4 Photography in product design

In this thesis, I will only mention a few steps that photographers suggest us to use if we want to use photography to present our furniture. 7 steps for optimizing furniture product photography:

1. Prepare your furniture – Use furniture polish to clean your product before photographing.
2. Set up your studio – Use a white backdrop like seamless white paper, a sheet, or a wall.
3. Select your lens – A 50mm - 75mm lens, or a zoom lens, is effective for product photography. [6]
4. Position your tripod and camera – A tripod keeps your camera stationary and ensures consistency from shot to shot, while also eliminating camera shake and allowing you to optimize settings [6]
5. Don't over style – It may look pretty and fun when you style your furniture, but it's usually a mistake. Your customer may not like the way you style your piece, and in most cases it will be a distraction or conceal something your customer wants to see. [6]

6. Shoot multiple angles – More product images lead to more sales. Highlight details and areas of interest to customers. [6]
7. Optimize in Post-Production – After photographing your furniture, it's time for post-production. A little polish in a program like Photoshop will go a long way to increasing your image quality and optimally presenting your product. [6]



*Figure 3 Furniture Photography. Left: before retouching. Right: after retouching*

## 2.2 Computer-Generated Imagery CGI

CGI refers to any visuals created with a computer as opposed to created with a camera or by hand. It is used by many different industries for various purposes. Gone are the days where creating photorealistic CGI was either impossible or too expensive for small businesses to consider. We see CGI every single day without even realizing it, here are some of the industries and where they use CGI. [7]

- Entertainment - Nearly every film today has CGI in it at some level, especially the stunts, special effects and sets.



- Advertising – Ad agencies use CGI to turn a concept or idea into visual message. Most Ad agencies blend photography and CGI to create powerful advertisements.
- Automotive – Nearly every car commercial or advertisement you see is a rendering, not a photo.
- Luxury – Goods such as watches, jewelry and sunglasses are often rendered out rather than photographed.
- Medical – Instructions for medical procedures are often created by rendering the medical instruments.
- Technology – Ads for mobile devices, computers and other glossy gadgets are almost always renderings and not photos.
- Health and Beauty – Perfume bottles, shampoo containers and even medications and packaging is often rendered for print ads or commercials. [7]

Computer-generated imagery opens up many new avenues for even more creative and stunning imagery. When building a CGI room set, essentially, we are creating a digital file. This, in turn, means it can be re-opened and revisited at any time in the future. You can change anything within the room, from door finishes, styles and handles, to architectural features and styling elements. [8]

Key terms in CGI are:

- Rendering – is a single computer-generated image.
- Animation – a series of computer-generated images called frames. If we play the frames in sequence (around 24 frames per second), we have CGI in motion.
- CAD – short for Computer-Aided Design. CAD programs are used to create 3D models. Those models are often used to create CGI.
- Geometry – refers to the data that 3D models are composed of. Each 3D modeling program has its unique set of strengths, weaknesses and features. The needs of the final CGI will often dictate which 3D application is used.
- Application, Program, Package – all refer to computer software.
- Post – short for post-processing and is used to add final touches to CGI. In some cases post can be used to speed up a 3D artist's process. Final touches such as backgrounds, color, lighting, scratches, dust and other details will be added after the rendering has been created.

If no post will be used, the scene is set up for final output and the image or animation is rendered. [7]

### 2.2.1 It can help with the design process

When you see a prototype brought to life in CGI, it can suddenly help you see it in a different light. CGI is an incredibly helpful tool in design of a product as it gives a tangible proof of how it will look and work. CGI is also a great way to pitch or even advertise and sell the product before the final manufacturing has taken place. This instantly puts you ahead of the game by being able to demonstrate what you have, before you even have it. [9]

CGI is so adaptable that just by starting off with a still of your product, it opens doors to many other possibilities. This then can be adapted to animation, to be used on mobile, to be made interactive and even to become part of a 360 or VR experience. Once the model is there, there really are no limits as to what can be achieved. This makes CGI more consistent than the products of several different photo shoots. CGI gets the audience in closer with your product, often making it feel more tangible than the actual product itself. [9]

### 2.3 Render

Rendering is the process of creating an image from a model by means of software. Used in architecture, simulators, video games, movies and visual effects, but in this thesis, we will focus on its use in design visualization. These product visualizations can be used throughout the design process, from communication early concept ideas to assessing customer interest in proposed product ideas to helping “sell” final products online or through marketing and sales collateral. Rendering gives the final appearance to models with visual effects, such as shading, texture mapping, shadows, reflections and motion blurs. [10]

Product designers and engineers typically render product models during several different stages of product development. Rendering is commonly done both early during concept development to facilitate buy-in and then again after 3D CAD models are completed to create the visual assets used to sell and support the final product. [10]

In the most basic terms, 3D rendering is two dimensional representation of a computer wireframe model that has been given properties such as texture, color, and material. Every rendering starts as

a 3D model, which is represented by a series of flat geometric shapes connected together in three dimensional space. These shapes are called polygons. These rudimentary geometries are the backbone of any digital 3D model and are manipulated and created using computer software such as Rhinoceros 3D, Google SketchUp, or 3D Studio Max. The models themselves are often very crude, represented in the digital space as a simple wire-frame object or scene. In order to give these shapes real form, they must be introduced to texture maps, artificial light sources, and a number of other filters that turn out at the other end what amounts to a finished 3D rendering. In addition to modeling and rendering programs, there is also post-production software, I also mentioned it above. Photoshop is a post-production software that gives each work the final aesthetic touches that are necessary for a rendering to be incredibly true to life. [11]

### 2.3.1 Types of 3D rendering

1. **Software rendering** – produces images of the highest quality, letting you achieve the most sophisticated results. Computation occurs on the CPU, as opposed to hardware rendering, which relies on the machine’s graphics card. [1]
2. **Hardware rendering** – uses the computer’s video card and drivers to render images to disk. It is generally faster than software rendering, but typically produces images of lower quality compared to software rendering. [1]
3. **Vector rendering** – lets you create stylized renderings in various bitmap image formats and 2D vector formats. [1]
4. **Cloud rendering** – rendering in the cloud takes advantage of virtually infinite computing power. Quickly create photorealistic and high-resolution images in a fraction of the time required on your desktop. [1]

### 2.3.2 Autodesk 3D Studio Max

3ds Max is one of the most powerful designing software, is a 3D modeling program used for animation and simulation by gaming, film and motion graphics. The software was developed by Autodesk Media and Entertainment. 3ds Max software consists of many rich features that helps the modelers, the renders and the designers to create flawless photo-realistic, 3D images as well as 3D animations of any construction element. This software has a wide ranging usage in Media, Advertisement and Entertainment industry. [12]

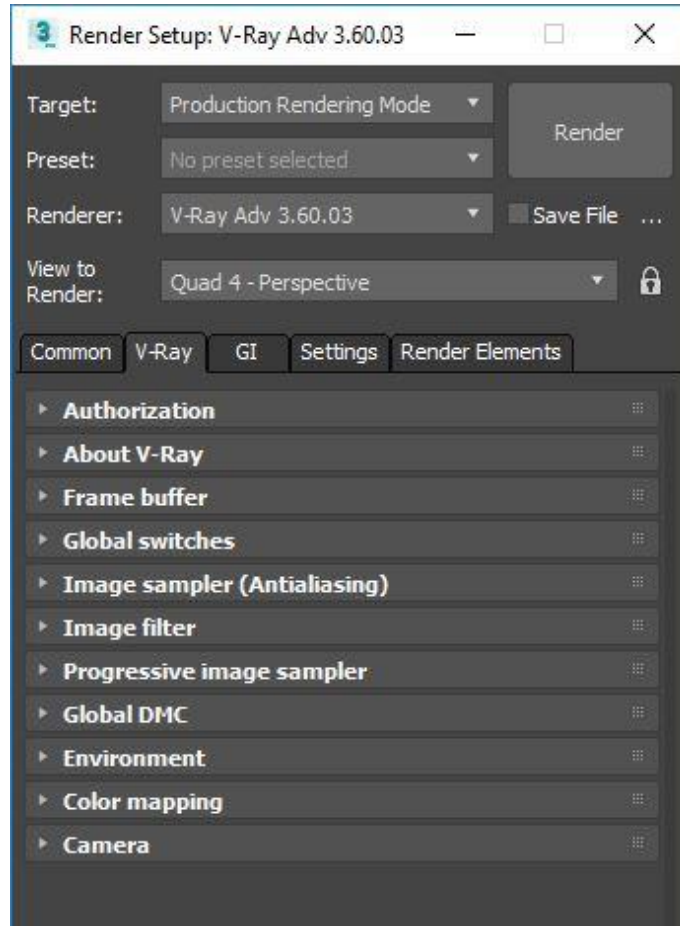
In product design, 3ds Max can be used to render photorealistic images to show off products in their best light (furniture, automobiles, gadgets, etc.). In the real estate and architectural industry, 3ds Max is used to create accurate photo-realistic imagery of buildings before they are built, and visually appealing living spaces as showrooms even before they become available. 3ds Max is also used in scientific, engineering, medical, manufacturing, educational sectors to graphically and visually show processes that are organic, medical, corporate or mechanical in nature. [13]

3ds Max software has excellent capabilities in developing the effective 3D models and it has great compatibility with Microsoft Windows operating system. Some of its versions have compatibility with Apple Mac operating system, 3ds Max version 2010, 2011, 2012 and 2013 is compatible with Mac operating system. [12] 3ds Max works with most major renderers, including Arnold, V-Ray, Corona and Iray, to help create striking scenes and visuals. In this thesis, we will talk more about V-Ray render and Corona render.

### 2.3.3 V-Ray Render

V-Ray is a rendering plugin for the 3D software, which supports almost every feature in 3ds Max. The plugin is made by a Bulgarian company named Chaos group. V-Ray is an extremely powerful tool when it comes to rendering. V-Ray has large arsenal of tools to its disposal, for example ray traced reflections, indirect illumination, caustics, anti-aliasing, etc. [14]

V-Ray is a plugin which means that it adds functionality to an existing program. V-ray's features mainly aim to creating photorealistic images, together with improving rendering speed. Most of V-ray's features can be found in the render setup dialog, but many other additions are distributed across the complete program. For example V-ray adds its own materials and textures, light types, a fur generator, a ton style effect, displacement modifier, frame buffer, effects, etc. [15]



*Figure 4 Render Setup Dialog V-Ray*

### 2.3.4 Corona Render

Corona renderer is a photorealistic ray tracer, used by computer graphic artists for the final frame production rendering mainly for architectural and product visualizations. Corona has a free version, and also a commercial release. The last couple of years they attracted thousands of users, and a lot of attention in the architectural visualization industry. Main advantages of Corona are simplicity and usability, namely how easy is the software to use in practice and how this fact increases artists' satisfaction and performance. Maybe Corona is not the fastest, most physical, or most feature-complete renderer on the market, but clearly is one of the simplest one to work with, which is pretty important for a lot of architects and designer who need to apply new technologies quickly to their workflow. [16]

Corona rendered is a new high performance photorealistic renderer, available for Autodesk 3ds Max and as a standalone CLI application. The development of Corona renderer started back in

2009 as a solo student project of Ondřej Karlík at Czech Technical University in Prague. Corona has since evolved to a full-time commercial project, after Ondřej established a company together with the former CG artist Adam Hotový and Jaroslav Křivánek, associate professor and researcher at Charles University in Prague. In August 2017, the company became part of Chaos Group, allowing for further expansion and growth. Despite its young age, Corona renderer has become a production ready renderer capable of creating high-quality results. [17]

The same as V-Ray render in Corona you have the render setup window, where you can change the parameters in the way you need them. As you can see in figure 5, there are so many options to experiment with. The one that I admire more for Corona render, in comparison with V-Ray render is the scene option where you can choose how long the render time will be. If the time duration is long, this means that the render quality is high, otherwise, the quality will not be that good.

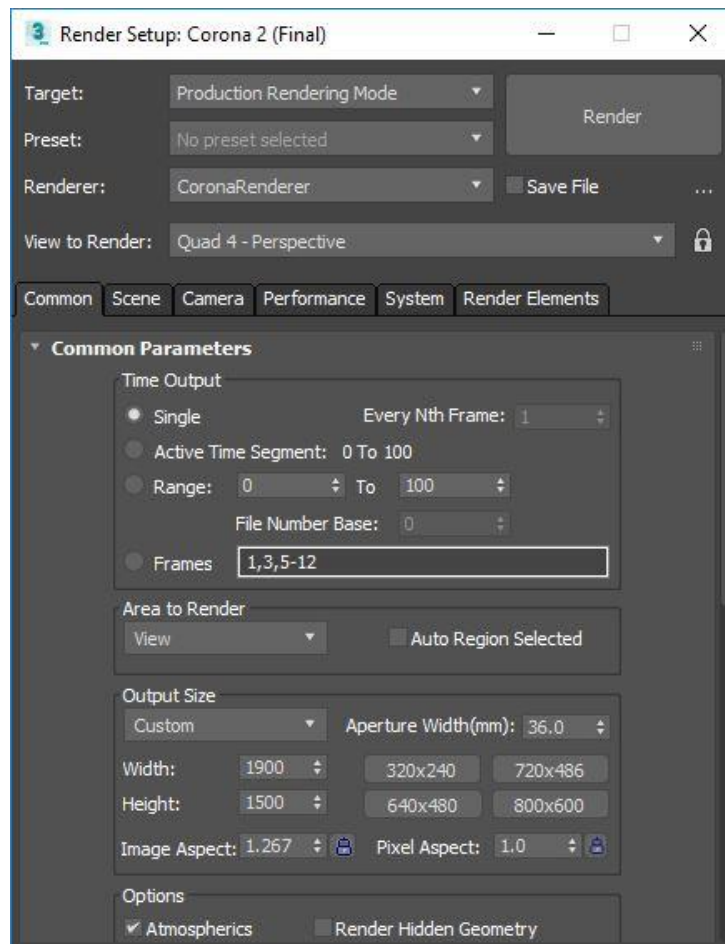


Figure 5 Render Setup window Corona

### 2.3.4.1 Rendering Quality

Corona renderer delivers predictable, reliable, and physically plausible results with no compromises in quality. Corona renderer offers both biased and unbiased rendering solutions. By default, Corona renderer uses a slightly biased solution, very close to being unbiased but considerably reducing render times. This is the recommended solution and works without you having to do any setup whatsoever. Corona renderer will always deliver crisp, realistic results without splotches, interpolation artefacts or any other visual imperfections. Although most users never need it, the option does exist to choose to render in a fully unbiased mode using advanced rendering algorithms like BDPT/VCM. These algorithms can enhance certain specific features in rendering, such as caustics, but with the associated performance penalty. [18]

Traditionally, you had to choose between using unbiased algorithms with no caching and accept long render times, or using biased caching algorithms and deal with splotches, missing shadows, and sensitive input parameters. Corona renderer merges the best of both worlds, the UHD cache is significantly faster than plain path tracing, but does not suffer from artefacts, missing contact shadows, or complicated UI controls. [18]

The UHD cache uses only partial caching, so does not try to interpolate everything. While this is slower than a fully cached solution (such as irradiance caching), it does not create artefacts, the only noise that eventually goes away. The UHD cache is an ideal solution for animation and significantly reduces flickering even when light sources or geometry are moving. This is especially important when the cache cannot be precompiled. [18]

## 2.4 Advantages and Disadvantages of photography and 3D rendering

In today's world, marketing is everything and compelling visual presentations can exhibition your designs in ways words cannot express. Here are some advantages and disadvantages for both photography and 3D rendering.

### 2.4.1 Advantages of 3D rendering

#### 1. Perfect images every time

Every time, nothing in the real world is perfect. But in the virtual world everything is, unless you choose otherwise. 3D images have no colour cast issues, producing the perfect balance and precise exposure on an image. [19]

## **2. No retouching**

Most photographers charge for retouching to remove flaws or distractions. 3D images only contain what has intentionally been designed and therefore no retouching is required, ever. [19]

## **3. Controlled conditions**

Photographers have to wait for the perfect sunset or perfect condition in which to take an image. In 3D you can recreate any condition, any time of day, at any geographical location on the planet. [19]

## **4. Lighting challenges**

Interior lighting can be easily controlled with 3D rendering. The type of lighting condition can be easily changed in minutes. In photography, you either have to introduce a secondary light source or use what you have in the environment. [19]

## **5. Staging**

Moving and organizing furniture/products for photography can be time consuming. 3D allows us to move objects with the click of a mouse, saving time and money. [19]

## **6. Making changes**

3D is all about flexibility. You make the changes you want, when you want. Even after your publication, you can reuse images in other campaigns in another form or context. When a photo shoot is done, it's done. You can't go back in time wishing you had asked for an image you now need. [19]

## **7. Stream line manufacturing processes**

Unnecessary costs and time delays are trimmed to perfection. With 3D software, you can improve the communication throughout your organization, getting everyone in sync. [20]

## **8. Accelerate product introductions**

3D renderings make it so easy to share your awesome new collection, it will delight your community in no time. [20]

## **9. Publish 3D rendering online**



Widen your audience and get an overall idea about what people think about your product. [20]

#### 2.4.2 Disadvantages of photography

##### 1. **Must hire an interior designer except photographers**

To create a beautiful image of interior design you will most likely have to hire a designer. Good result usually stems from cooperation of photographer and designer, and they must be a good match. For example, if the photographer thinks that there is something missing in the shot, the designer will have to decide what can be changed. It's the designer who generates all ideas, but the photographer will have to determine whether they will look good. [21]

##### 2. **Long Process, slow workflow**

Making a professional photograph for product design is not an easy process that only takes having a photographer and his camera. After the shoot is over, if you suddenly decide that you need just one more shot, everything will have to start over again. [21]

##### 3. **Environment**

There must be an appropriate environment. For example, in order to create a picture of kitchen interior you will have to build a complete kitchen. A single room doesn't sound like a big problem, but what if you have to create the whole collection. [21]

##### 4. **Decoration**

All accessories and decoration must be thought through beforehand, and you should have enough variety to receive good pictures. It will be hard to add or change something once the shoot starts. [21]

##### 5. **Adjustments**

Whether you need a new collection or just a small correction in the existing one, you'll have to start the work from the top. Of course, the colors can be changed during post-processing, but adjustments in design will be much harder to make. [21]

##### 6. **Angles**

You always have to think about the necessary angles. It might not seem like a big problem, but if you need to show your product from the inside or during real world exploitation. It can be simply impossible to do with the photographic images. [21]

## 7. Time

You can't receive the pictures right after the end of the shoot. Post-processing always takes some time, which means that you will receive the result only in a week or so. [21]

## 8. Cost

Professionally made pictures aren't cheap. If you figure out a price of one image, it may not seem very comfortable. [21]

### 2.4.3 Advantages of photography

The main advantages of photography are that you have a true bump of reflection, highlight and you see it in an ambient with different parameters of light. Product photography has the obvious benefit of not requiring the expense of creating a 3D model. If the product's geometry is very complex and the limited amount of desired views and comparisons doesn't warrant the time required to create a versatile 3D model, product photography can be a very cost effective means of visualizing your product. Also, while metals, plastics, and woods render very well, textiles and fabrics are often better suited to being photographed. [22]

A product is better suited to product photography when your project matches these criteria:

- Product geometry is very complex
- The required views, materials, colors etc. have already been defined
- Product contains lots of fabrics or textiles
- Product has already been manufactured [22]

### 2.4.4 Disadvantages of 3D rendering

There are times that it is necessary to feel and touch the model to feel its texture and the composition of the materials with which it was created, it is something that you cannot have it with 3D rendering. 3D modelling software is very expensive for most people, so its dissemination has not taken the boom it should. Rendering a product requires building a complete 3D CAD model, which can be time consuming and expensive if the geometry is complex and the number of components is high. [22]

A product is better suited to photorealistic rendering when your project matches these criteria:

- Need to visualize physically impossible situations such as internal components or cutaway views
- The product has not yet been manufactured
- Want to include many combinations of different backgrounds, material colors, textures, scenes, etc.
- Product is metal, plastic, rubber or wood [22]

## 2.5 Why IKEA left photography for 3D rendering

Photorealism is one of the largest and most commonly used areas in the field of 3D. At the beginning of the 21 century, the Swedish furniture company IKEA started to digitally store all of their products in a large database. At the beginning of this project, all the work was done by photographers. However, IKEA realized the potential and the opportunities of this new growing market simply named 3D. IKEA, one of the world's largest and most successful multinational companies, is known for providing some of the best high-quality, ready to build furniture in the world. After much deliberation, IKEA decided to make a drastic the way they produced the images of the furniture. Prior to 2004, all of the pictures of furniture were done exclusively through photography. That all changed when Martin Enthed and his team took on the task of implementing 3D rendering to display their furniture. [23]

The company's goal is to create visually appealing furniture that appeals to wide array of customers. As one of the world's leading design companies, IKEA makes more than two thousand new products a year, products that can each be assembled in a variety of combinations. Now imagine having to shoot or reshoot photos of these products with every little alternation or modification that comes from a company of over 200,000 co-workers. [23]

At some point, photography simply becomes inefficient. Which is why, in the summer of 2004, IKEA started making serious steps towards CG rendered imagery of its products. In the catalogue published in autumn 2006, the "BERTIL" chair premiered in all its polygon glory. [23]



*Figure 6 "Bertil" Chair, First IKEA 3D rendering*

Using 3ds Max and V-Ray, IKEA creates around 75% of all of their furniture images. They've effectively built a 3D bank of all of their images that they can use in whatever set they like, allowing them to create affordable marketing initiatives all over the world. [24] Though photography is generally an excellent way to capture furniture, IKEA wanted to try something new that would enable the process to not only be faster, but much simpler and cheaper. When IKEA wanted to make the transition, they wanted to keep the same feeling that had made their previous images so successful, the ability to make the environment feel "lived in". This was the initial challenge that IKEA had to undertake, they wanted to use 3D rendering without their customers noticing any significant changes. [23]

The advantage of using 3D rendering is that IKEA is able to not only show product individually but combine them to build a 3D room set. The reason for such a successful transition was the use

of 3D Studio Max and V-Ray to create the 3D renders. IKEA is able to take advantage of this software by creating the most photorealistic images without second guessing if the images are computer generated or not. V-Ray also comes with a large number of settings that enable you to tweak the values of the image to create a quality final product. [23]



*Figure 7 A digitally created kitchen scene by IKEA*

IKEA has taken these techniques and developed a standard for 3D rendering and furniture. This standard has enabled them to create the highest quality images that do not need to be altered for years to come. With technology moving at such rapid rates, creating a standard for furniture rendering is becoming harder for IKEA to maintain. That being said, by taking the time and energy necessary, IKEA will continue to create some of the most realistic 3D rendering for furniture for years to come. [23]

### 2.5.1 How IKEA is using Virtual Reality

IKEA is known for its groundbreaking approach to marketing. It's one of the brands that have been constantly innovating, and merging technology with everyday products, to make even more useful and adaptable to today's needs. From its concept kitchen table, to its wireless charging product series, IKEA is at the forefront of innovation. With its latest endeavor, the furniture giant is looking to educate consumers about its products, with the help of VR. [25]

IKEA is stepping into virtual reality by creating a game for new store openings. For its store in Dallas, IKEA collaborated with media agency Wavemaker to bring VR experiences to store visitors. The content created for the specific store would include a pillow-fight game, closer glimpses at specific furniture items, and even an experience where viewers can hang out with pandas on bamboo plants. The purpose of the effort, was to educate store visitors on the hidden aspects and advantages of the products, as well as sustainable sourcing and development of furniture. Although the launch of the VR experience was rather limited and confined to one story only, it was met with success, as hundreds of visitors lined up to check it out. The controlled launch could also mean that IKEA is trying this new marketing experience, before taking it to all of its stores worldwide. [25]

IKEA virtual reality showroom is an interactive showroom that uses the immersive power of virtual reality to offer an innovative 3D product experience. With new ways of exploration and visualization, customers can bring IKEA rooms to life, opening their mind and home to new possibilities. The virtual home experience lies at the center of IKEA's home furnishing hub, a playful interior lab where IKEA focuses on inspiring and co-creation with its customers. The VR experience works like a creative primer by inviting them to visualize different combinations. It sets customers free to think beyond the given things, making the most out of their visit to the hub and helping them truly find their very own room for life. [25]

Crafted in and composed of high-end, photorealistic 3D renderings, the application provides a captivating 360° stereoscopic interior decoration experience with brilliant product staging, no matter the configuration. The Virtual Home Experience intertwines a recognizable visual interface and motion design with touchless interactions. The result is a multi-dimensional signature brand and product experience that looks and feels like IKEA. Simple interactions and clever focus

mechanisms allow the user to customize the room's interior and many facets of its environment in a glimpse. [25]



*Figure 8 IKEA Virtual Reality Showroom*

As trends and seasons change, so does the Virtual Home Experience. It not only came to be through many iterations, it will also continue to evolve through a culture of collaboration between IKEA and its customers. The intimate moment inside the virtual room leverages an opportunity to co-create with visitors, letting users contribute to the development of the room by submitting feedback from within the experience. As mentioned before, IKEA has been extremely effective when it comes to adopting technology. It's not the first time it's exploring the world of "realities," having launched its namesake Place app, which allows users to virtually "place" IKEA products in their space, before buying them. [25]

### 2.5.2 How IKEA is using Augmented Reality

For years, IKEA has relied on shoppers visiting its stores to sell furniture, but now, it's hoping a smartphone will drive sales. The retailer is using augmented reality to let customers preview how furniture looks on their smartphones before they buy. Customers use IKEA Place, one of the first apps to use Apple's ARKit tech, to place the company's furniture wherever they envision it in their homes. In IKEA Place, customers can view 3D renderings from different angles of over 2000 products before reserving the ones they want in the app, which directs to the IKEA site to complete purchases. [26]



*Figure 9 IKEA using Augmented Reality*

IKEA has struggled with e-commerce sales partially because of its slow adoption of digital. Allowing people to see what a product would look like in their house without embarking on a three hour IKEA trip could help the company with online sales. The app launched in the U.S. on Sept. 19, coinciding with Apple's iOS 11 update, and is rolling out to other markets over the coming weeks. Michael Valdsgaard, leader of digital transformation at Inter IKEA, declined to reveal how many times IKEA Place has been downloaded but said the reaction has been positive, noting that



people are sharing how they're using it online. Valdsgaard said "The most important thing for us is that we're not a tech company. In order to sell furniture, we have to understand technology and try to move the direction it's moving." [26]

Seeing lifelike versions of IKEA's products in rooms lets shoppers make a reliable buying decision. Early feedback on social media for IKEA Place inspired its developers to introduce a search feature for people to find specific products, which they built and launched in five days. [26]

"Most people postpone purchase of a new sofa because they're not comfortable making the decision if they aren't sure the color is going to match the rest of the room or it fits the style. Now, we can give them those answers in their hands, while letting them have fun with home furnishing for free and with no effort," said Valdsgaard. [26]

The IKEA Place app first was available only in iOS App Store, and now is out for the latest Android phones. Google's version of the app runs on ARCore, its answer to ARKit that gives Android devices the power to run apps that can superimpose objects over live images even without special sensors or software. You can now download and install it if you have a Pixel, a Samsung Galaxy S7, S8, S9 or Note 8, LG V30, or an OnePlus 5, etc. Actually, you'll have to install it if you want to use any ARCore apps, which are bound to pop up one by one now that the platform works on more devices. That means you won't be able to run IKEA Place or any other ARCore app if you have a non-compatible phone, but Google says it's working to bring the platform to more devices throughout the year. [27]

In addition to launching Place for Android, IKEA has also added Visual Search to its apps. The new feature gives the applications the capability to search for items in IKEA's inventory, you just need to point your camera towards that piece of furniture that caught your eye. Finally, IKEA has launched a new game show series called Matchers Keepers that you can play with friends and family. You'll need to pick pieces of furniture over three rounds for a specific place in your home, and you get points for picking out matching items. All players will need to have access to IKEA Place, though, so any housemate with a non-compatible device will have to sit it out. [27]

## 3 Problem Statement

In the 20<sup>th</sup> century, photography was the main source for presenting the design of the product. When it comes to marketing and product promotion, presenting your product with clarity and effectiveness is extremely important.

Using photography in this case we will face a lot of problems, such as complicated workflow, high cost, colors, lighting, when images are done you cannot make changes, you need to arrange a whole new photo shoot for just a few changes in the scene, sometimes images are not done in the right time so you will be late to present your design to the world, etc., and for my opinion the most important thing is time.

So this thesis is going to treat the photography problems and in what way you can avoid them because to be in the eye of your customer, you need a good marketing for your product.

### 3.1 Research Questions

1. How should a computer-generated imagery be created to look photorealistic?
2. What are the limitations, problems, pros and cons for both photography and 3D render?

## 4 Methodology

In order to complete this dissertation and to get a proper result, we have to pass through some activities.

First of all, we have read a set of books and researches about photography and 3D rendering which are included in the chapter of the literature review. Afterwards, we defined the problem statement according to market requirements for product design and photography problems.

It's modelled a 3D product design using 3D Studio Max and Corona render version 2, which shows the solution for the problems declared in the chapter above.

## 5 Case study

I will be modelling a bookshelf that I really want to have in my house. To complete this I will be working with 3D Studio Max 2018 software and Corona render version 2. I will present step by step how to create photorealistic CGI. It will also be presented in a room set. In this chapter I'll only show the workflow, whereas in the next chapter you will see render form of the model.

### 5.1 Modelling

I start the model by using boxes. The brown boxes are in length: 1.76m, height: 0.03m, width: 0.3m. Those four little boxes you can use as a chair and then you can put them back into the shelf.

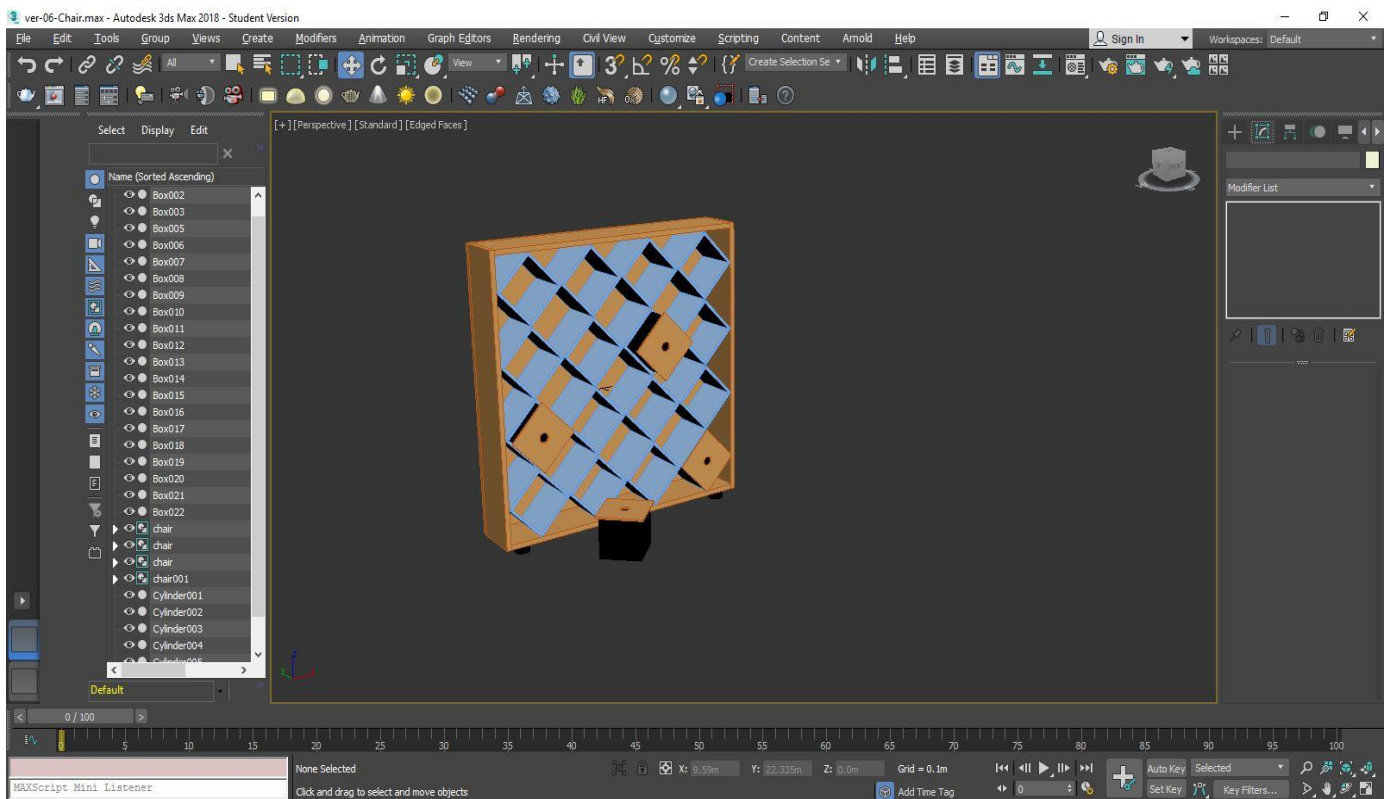


Figure 10 A screenshot of the workflow

### 5.2 Texture

For texture, I chose to use wood texture, I used it on the shelf and also on the floor. For the shelf, I applied Rovere Chiaro texture which in English means Light Oak. Whereas for the floor I applied Wood Planks Shaw Classic Hickory texture.



*Figure 11 Wood Planks Shaw Classic Hickory Floor Texture*



*Figure 12 Rovere Chiaro Shelf Texture*

## 5.3 Colors

In my project the only place I'm using color is the walls of the room, I chose the Silver color, the code for this color is R:192, G:192, B:192. The color window is in the right panel of the window Name and Color. You can alternate between two versions of the Object Color dialog at any time by clicking the appropriate Basic Colors toggle:

- **3ds Max palette:**

Contains a fixed palette of 64 colors, plus a custom palette of 16 user-defined custom colors.

- **AutoCAD-compatible version:**

Contains a fixed palette of 256 colors matching the colors in the AutoCAD Color Index (ACI).

Use this version when you want to assign object colors that match the AutoCAD Color Index.

An advanced way to use colors is to open the material editor window and then you click on the diffuse option, next it will open another window as you can see on figure 13, where you can write the code of the color you want to use.

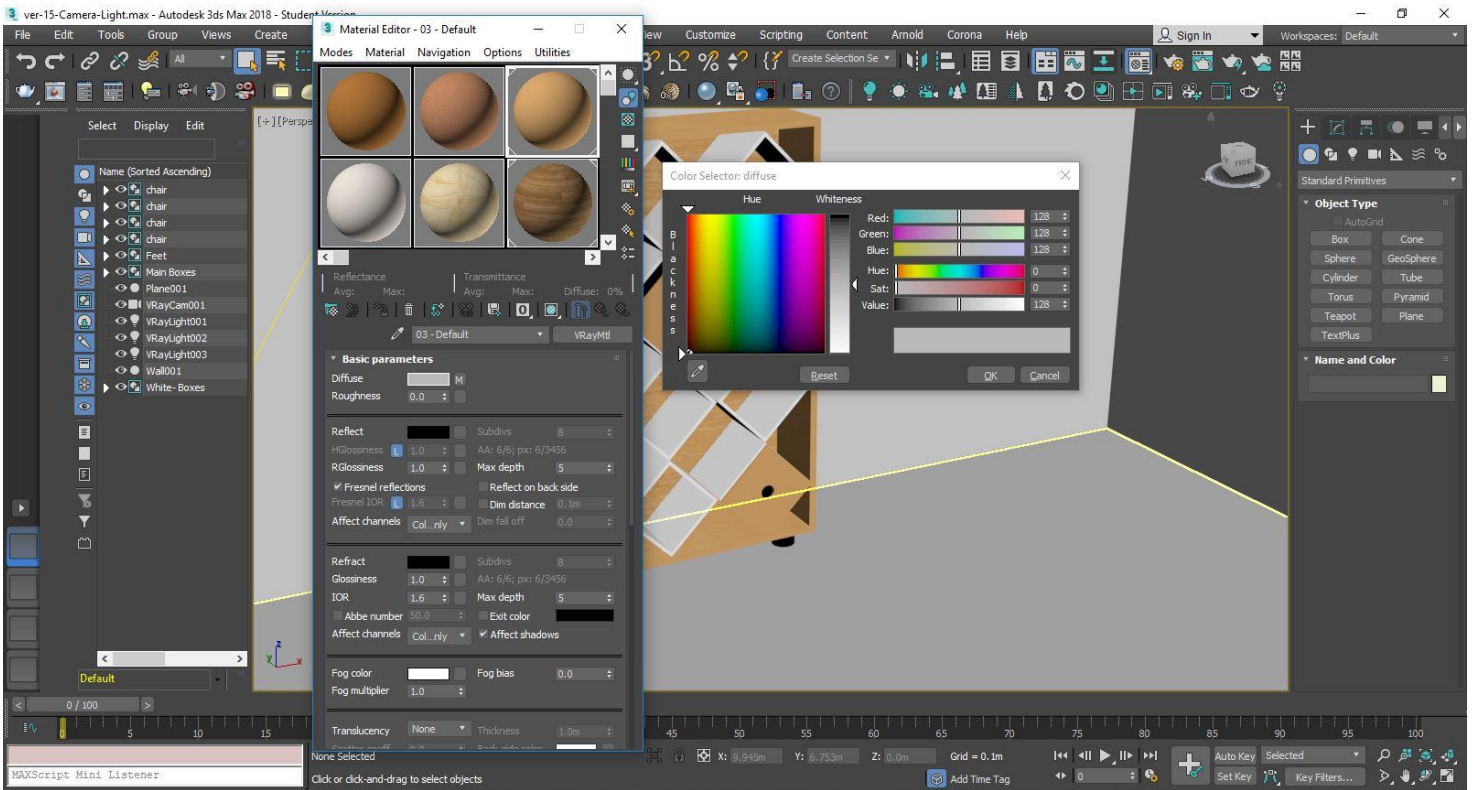


Figure 13 Color Selector: Diffuse

## 5.4 Light

The light that I'm using is the V-Ray Light. It is a plane light, the temperature of the light that I'm using is 4000K. The temperature of the light is an important element because that is what makes the ambient more soft or white cold. The three primary types of color temperature for light bulbs are:

- Soft White 2700K – 3000K
- Bright White/Cool White 3500K – 4100K
- Daylight 5000K – 6500K

The higher the Degrees Kelvin, the whiter the color temperature. You can use more than one light it depends in your scene.

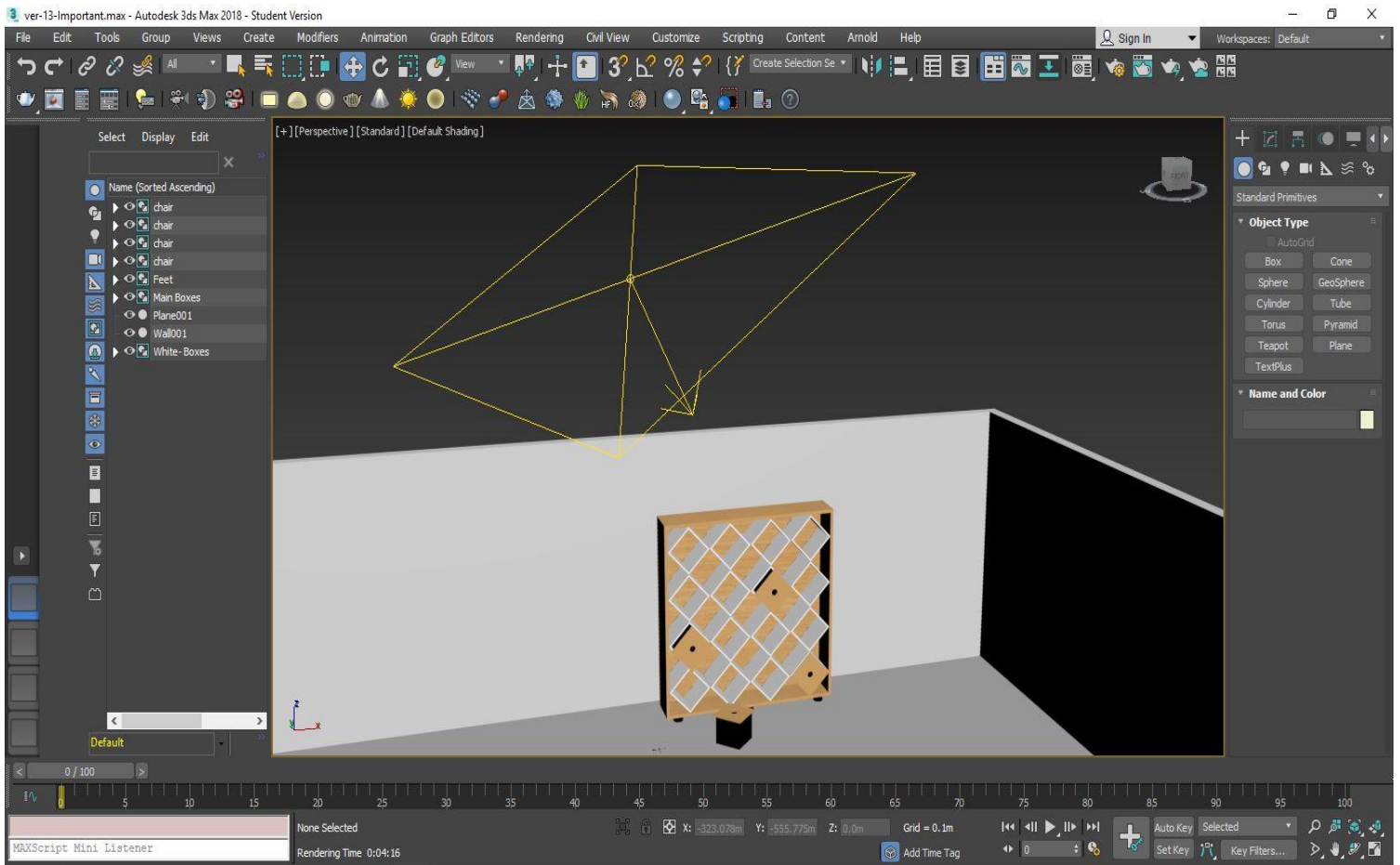


Figure 14 V-Ray Light

## 5.5 Camera

I'm using the V-Ray Physical Camera. The V-RayPhysicalCamera uses real-world camera settings such as f-stop, focal length, and shutter speed to set up the virtual CG camera. It also makes it easier to use light sources with real-world illumination, such as V-RayLight with physical units or V-RaySun and V-RaySky. Basic parameters of the camera you can find them in the right bottom of the window. The type parameter determines the type of the camera. This mostly has an effect on the motion blur effect produced by the camera. The type of the camera that I'm using is *still cam* which simulates a still photo camera with a regular shutter, the target parameter specifies whether the camera has a target in the 3ds Max scene or not, in our scene the camera has a target, target distance is 0.2m, zoom factor is 1.0, etc.

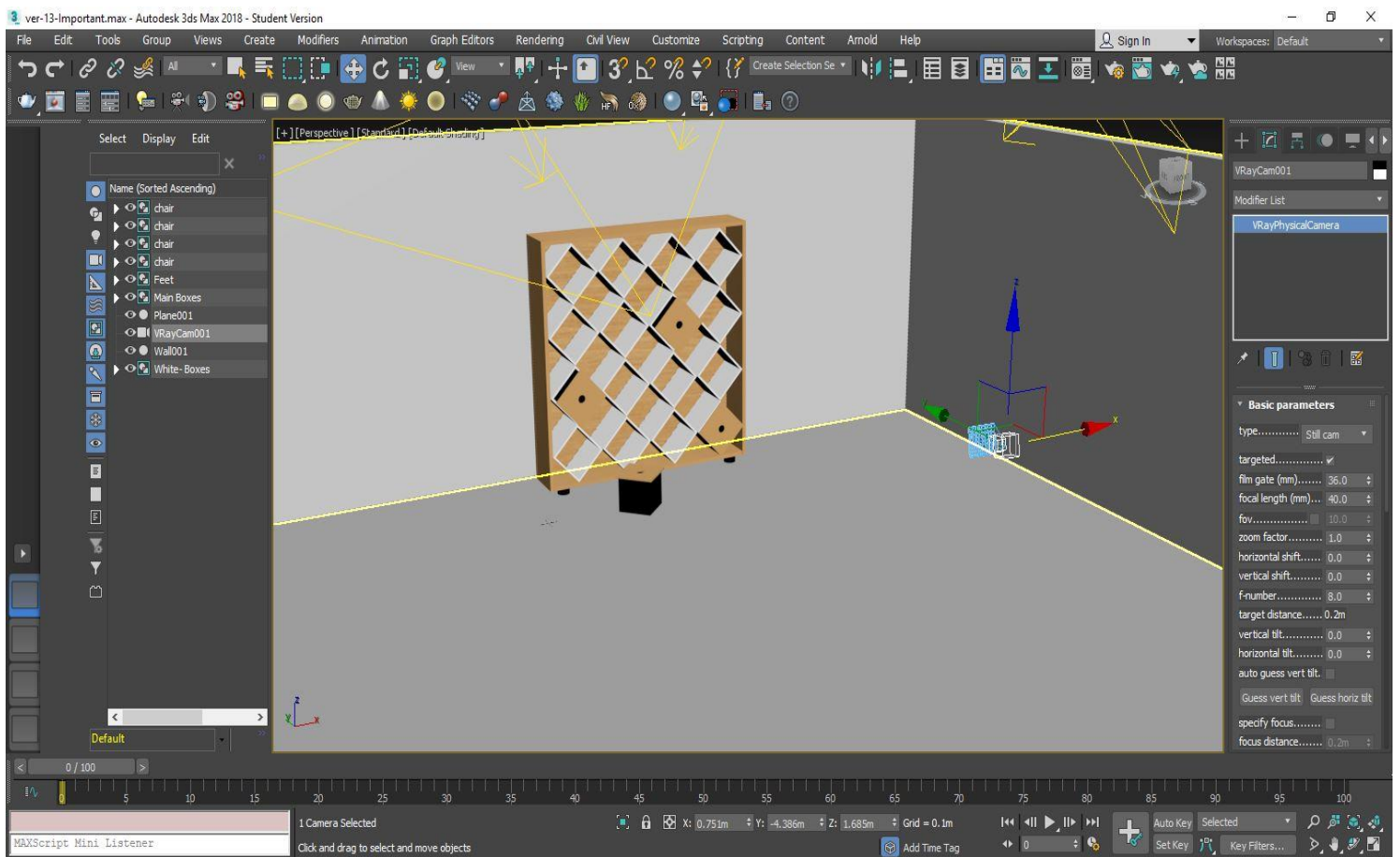


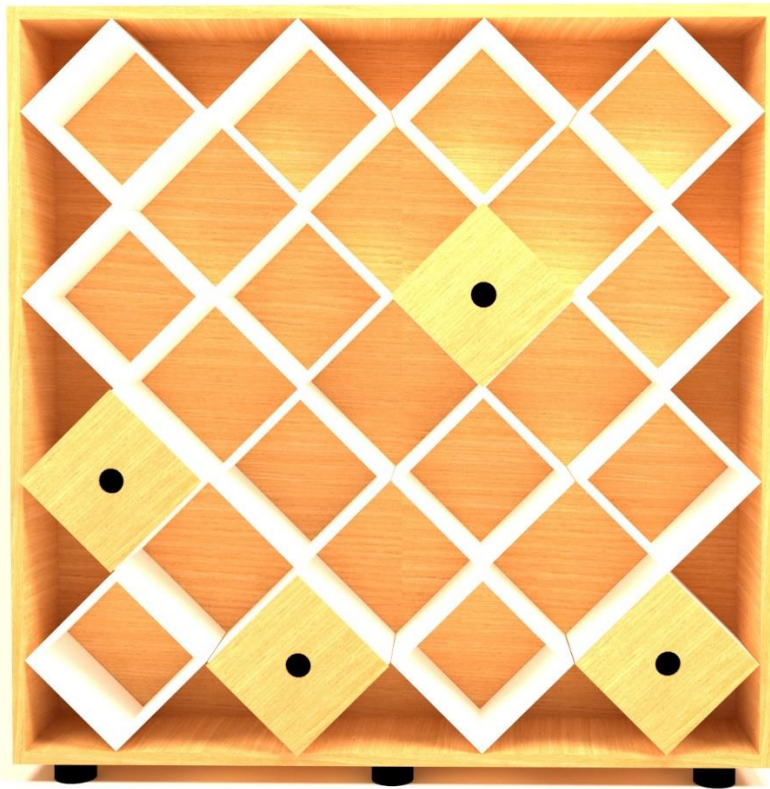
Figure 15 The VrayPhysicalCamera



## 5 Results

This chapter consists of figures which present the rendered form of our 3D model. This is the form of our product that will be seen by our client.

The figure below shows the rendered form of my bookshelf 3D model. To make this render I used Corona render version 2, you can edit the settings of the render in the render setup window<sup>3</sup>. In the Common Parameters, in the Time Output menu I used *Single*, in the Output Size I set *width: 1900* and *height: 1500*. In the Scene menu, in the General Settings, I set the *Time Limit: 2h 30min*, this time option offers you to set the render time duration.

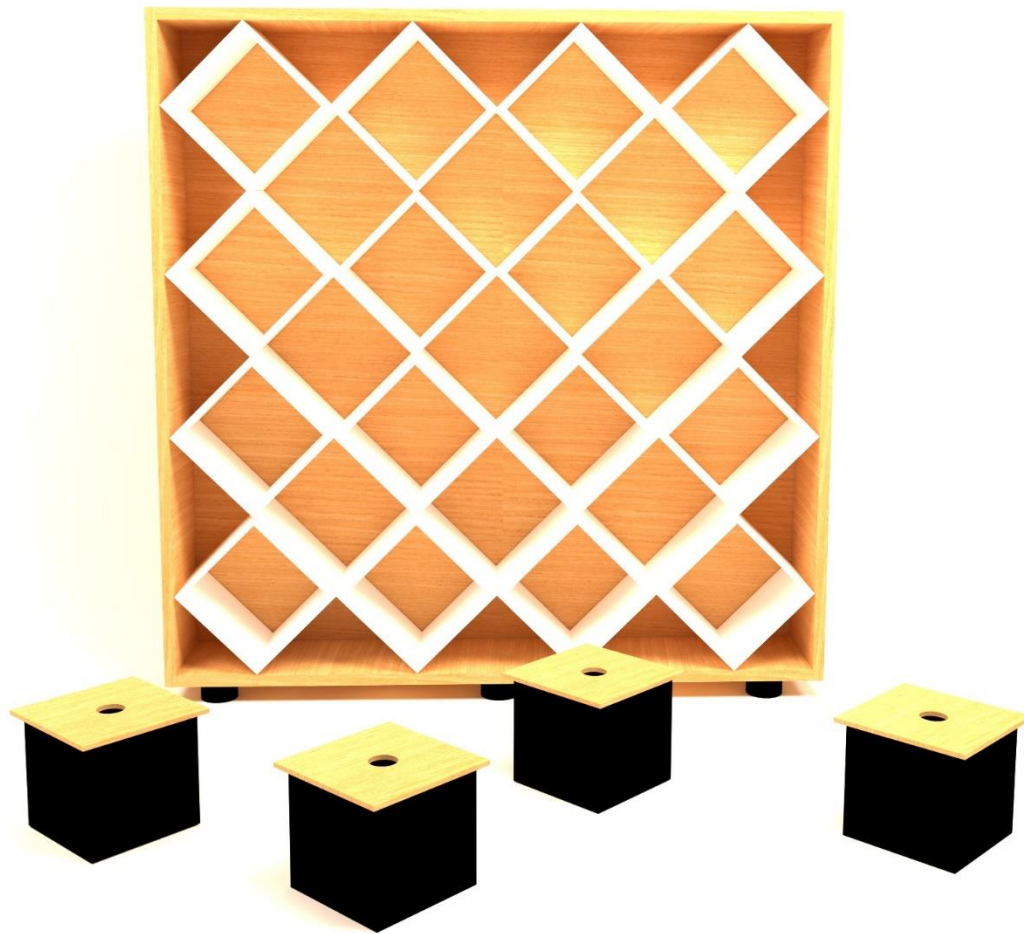


*Figure 16 First Render*

<sup>3</sup> Chapter 2.3.4 Corona Render, Figure 5

On the Camera menu, I only checked *Use simple exposure*, on the Performance menu, Global illumination, primary solver is *Path Tracing*, and the secondary solver is *UHD Cache*<sup>4</sup>, and other settings is no need to change them unless there is a problem.

Figure 17 shows the second render, where you can see that those boxes can be used to sit or to put something on them, after that, you can put them again in the bookshelf so in the room you can have again the space you need.



*Figure 17 Second Render*

---

<sup>4</sup> Chapter 2.3.4.1 Rendering Quality

Figure 18, shows how the bookshelf looks like filled with books, those boxes you can also use as a table to put your drinks or the book that you're reading and not only to sit.



*Figure 18 Third Render*

Figure 19, shows the bookshelf in a room. This is a good way to present your model because you can see how it interacts with other models in the room.



*Figure 19 Fourth Render*

The figure below shows the room with the bookshelf decorated with a lot of books. I designed the room as I wanted my room to be, the other 3D models I got them for free, these models are available online in different websites, you can also pay for a model, or take it for free. You can also model all of the 3D models that you want to use in a room set, but if you want to promote your product fast, you can use those free models.



*Figure 20 Fifth Render*

Figure 21, shows how the room looks like in day time and in the night time. The first one is day time and the second one is the night time.



*Figure 21 Day time and Night time*

## 7 Conclusion

According to achievements during the development period of the bachelor thesis, we can conclude the objectives<sup>5</sup> of our research has been realized. The whole study was devoted to finding a solution about the problems that happen during photo-shoot to promote product design, by using and combining recent technologies. During the development of our research we had to pass through several steps, and used the 3D modeling software, in order to reach our objectives. We also answered the research question<sup>6</sup>, the answer for the first question you can find in the case study chapter and for the second question in the literature chapter (see 2.4 Advantages and Disadvantages of photography and 3D rendering).

The completion of the 3D model has been reached by using 3D Studio Max software and Corona render, with this we see that it is more easy to use CGI<sup>7</sup> instead of photography if you want to promote your product design fast and accurately. When presenting any type of design solution to a client, it's always good practice to produce highly detailed representations and illustrations of the entire 3D model so as to give the right perception of room spaces.

Another advantage of CGI is that the customer is also included in the design cycle because he can even actively participate in the design process, propose modifications and see the results for himself.

There's a cliché that says it best "The sky's the limit". Artists and engineers will continue to push the limits of what's possible as long as limits exist to push. 3D rendering and visualization will soon touch the entirety of industry in the developed world.

3D rendering is here to stay, and I have a feeling we've only begun to scratch the surface of what's possible.

---

<sup>5</sup> Chapter 1.1 Objectives

<sup>6</sup> Chapter 3.1 Research Questions

<sup>7</sup> Chapter 2.2 Computer-Generated Imagery CGI

## References

- [1] Autodesk, "3D Modelling," 2018. [Online]. Available: <https://www.autodesk.com.au/solutions/3d-modeling-software>.
- [2] D. Rick, "A Brief History of Light & Photography," p. 24, January 2013.
- [3] PetaPixel, "20 First Photos from the History of Photography," 23 May 2015. [Online]. Available: <https://petapixel.com/2015/05/23/20-first-photos-from-the-history-of-photography/>.
- [4] K. Universitesi, "History of Photography from Camera Obscura to digital," *History of Photography from Camera Obscura to digital*, p. 114, 19 April 2001.
- [5] R. Anderson, "The World's First Colour Photograph," 10 October 2016. [Online]. Available: <http://thechromologist.com/worlds-first-colour-photograph/>.
- [6] Pixelz, "7 Steps for Optimizing DIY Furniture Product Photography," 29 February 2016. [Online]. Available: <https://www.pixelz.com/blog/7-steps-optimizing-diy-furniture-product-photography/>.
- [7] W. Gibbons, "Everything Business Owners Need to Know About CGI," 2016. [Online]. Available: <http://willgibbonsdesign.com/blog/about-cgi>.
- [8] T. Shuttleworth, "CGI vs Photography," [Online]. Available: <https://www.overviewstudios.co.uk/cgi-vs-photography-whats-best-choice/>.
- [9] E. House, "How CGI product visualisations will change how you sell," 7 December 2017. [Online]. Available: <https://www.engine-house.co.uk/how-cgi-will-change-how-you-sell-your-product/>.
- [10] 3. C. Editor, "A Picture's Worth a Thousand Words: Why Rendering is Increasingly Important to Product Development," 9 April 2014. [Online]. Available: <https://www.3dcadworld.com/pictures-worth-thousand-words-rendering-increasingly-important-product-development/>.
- [11] E. Render, "3D Rendering A Brief Explanation," [Online]. Available: <https://www.easyrender.com/3d-rendering/3d-rendering-a-brief-explanation>.
- [12] Rahul Tripathi, Simon Su, Shoeb Mohammad, , "What is 3ds max and its advantages?," 20 December 2017. [Online]. Available: <https://www.quora.com/What-is-3ds-max-and-its-advantages>.
- [13] P. W. K. Yang, "What is 3ds max and its uses?," 13 January 2016. [Online]. Available: <https://www.quora.com/What-is-3ds-max-and-its-uses>.
- [14] Anja Rackwitz, Markus Sterner, "Photorealistic Rendering with V-ray," p. 52, 15 June 2007.
- [15] A. 3D, "What is V-Ray?," [Online]. Available: <http://www.aversis.be/tutorials/vray/vray-20-what-is-vray.htm>.



- [16] T. Textures, "Lighting Interior Scene with 3DS MAX and Corona Renderer," 2018. [Online]. Available: <https://www.tonytextures.com/tutorial-lightning-interior-scene-with-3ds-max-and-corona-renderer/>.
- [17] C. Renderer, "About Corona," 2018. [Online]. Available: <https://corona-renderer.com/about>.
- [18] Corona, "Rendering Quality," 2018. [Online]. Available: <https://corona-renderer.com/features/rendering-quality>.
- [19] P. Oloo, "6 Advantages of 3D Rendering vs. Photography for Selling Products/Designs," 16 December 2014. [Online]. Available: <https://www.linkedin.com/pulse/6-advantages-3d-rendering-vs-philip-oloo>.
- [20] Tina, "REAL VS RENDER: CAN YOU SPOT THE 3D RENDERS FROM ACTUAL PHOTOGRAPHS?," 22 March 2016. [Online]. Available: <http://home.worldofwaw.com/real-vs-render-can-you-spot-the-3d-renders-from-actual-photographs/>.
- [21] A. CGI, "Photorealistic 3D Rendering in Traditional Marketing: Is it better than photo?," 22 June 2016. [Online]. Available: <https://archicgi.com/photorealistic-3d-rendering-marketing/>.
- [22] AARON, "Product Photography vs. Photorealistic 3D Product Rendering," 4 February 2018. [Online]. Available: <http://designtheproduct.com/2011/02/04/product-photography-vs-photorealistic-3d-product-rendering/>.
- [23] J. Kutyla, "How IKEA Effectively Navigated to 3D Rendering," 9 January 2015. [Online]. Available: <http://www.pixatecreative.com/ikea-3d-rendering/>.
- [24] J. Hobbs, "Why IKEA Uses 3D Renders vs. Photography for Their Furniture Catalog," 5 November 2018. [Online]. Available: <https://www.cadcrowd.com/blog/why-ikea-uses-3d-renders-vs-photography-for-their-furniture-catalog/>.
- [25] DemoDern, "IKEA Virtual Reality Showroom," 2018. [Online]. Available: <https://demodern.com/projects/ikea-vr-showroom>.
- [26] S. Joseph, "How IKEA is using augmented reality," 4 October 2017. [Online]. Available: <https://digiday.com/marketing/ikea-using-augmented-reality/>.
- [27] M. Moon, "IKEA's Place app is now out for the latest Android phones," 3 March 2018. [Online]. Available: <https://www.engadget.com/2018/03/19/ikea-place-app-android-arcore/>.
- [28] Pam, "What is Bitumen of Judea," [Online]. Available: <http://thesciencedictionary.org/bitumen-of-judea/>.
- [29] O. Dictionaries, "British & World English," [Online]. Available: <https://en.oxforddictionaries.com/definition/tartan>.