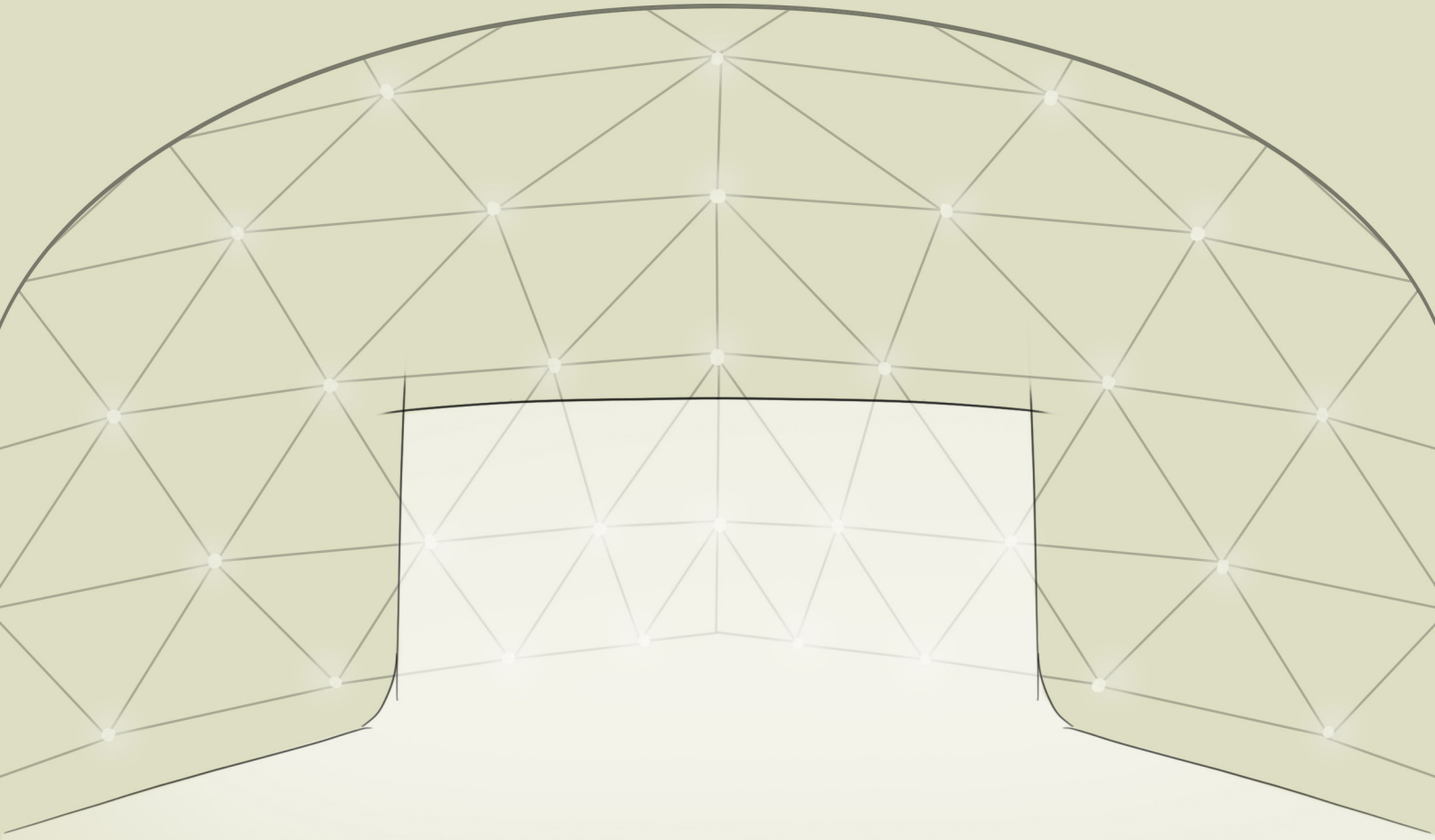

DESIGN OF THE LIGHT STUDIO FOR IDE STUDENTS FOR PROFESSIONAL PRODUCT PHOTOGRAPHY

Graduation project

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SUMMARY

During the study of Industrial Design Engineering (IDE), students learn to go through the design process of developing products. The final stage of presenting the result in a professional way is often underestimated. This project focuses on designing a solution for IDE students to make professional presentation photos of their products.
The design goal is to let IDE students understand the steps they need to take for photographing. In this way, they will feel confident and motivated to photograph their products in a professional way.

Research is done about photography, separated into three subsections: camera, light and editing. This information is used for developing the concept solution and integrate informative samples for the student into the concept.
During the conceptualisation phase, the light studio concept is developed. This concept consists of a dome-shaped structure with integrated LEDs and a camera, which is placed over the studio background. The subject can be placed inside. The interface on a laptop is placed beside the studio. Through the interface, the student can see a live image of the subject, control the placement and intensity of the light, change the camera settings and edit the photo directly. The interface provides information to give the student an understanding of light interactions, camera use and photo editing.

A prototype of the concept is build and tested with IDE students, see Figure 1. The results showed that students were enthusiastic about the live and direct feedback while changing the light position and camera settings. They were motivated to use the product again, which will increase the quality of their work. Some unclarity was found in the information given by the interface. This was due to missing visual support. Also, the live view, sliders for light placement, camera setting and editing options were not functioning within the interface but separately presented during the test, which might have influenced the interaction.
A redesign (Figure 2 and Figure 3) is made with iterations based on the user test results for conducting a second user test in a future research project. It is recommended for further research to create a prototype in which all elements (live image, camera settings, light placement and editing) are integrated into the interface and are interacting with the light studio. This way, the complete interaction can be tested and evaluated before presenting the product to the market.

Figure 1, Test setup. The light studio is placed on the left with the camera in front. The laptop with interface is placed on the right. The participant was sitting on the left chair and the facilitator on the right chair.

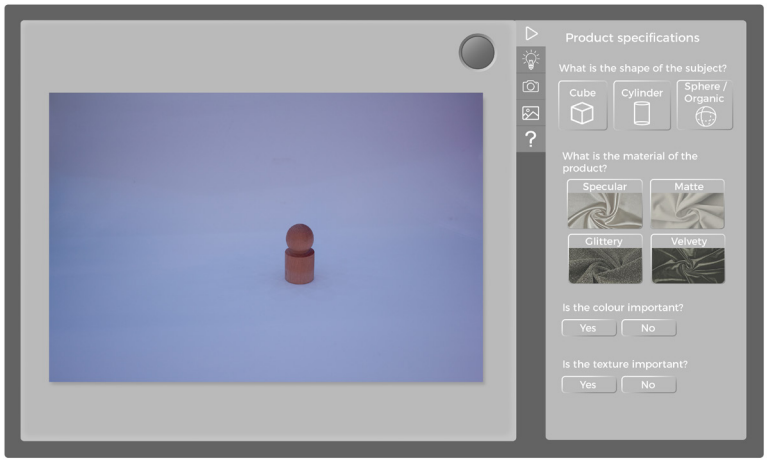


Figure 2, Final interface. The live view of the camera is located on the left. The different tabs in the middle of the screen are the navigation to the first page, light settings, camera settings, photo editing and additional information.

1. INTRODUCTION

Students of the faculty of Industrial Design Engineering TU Delft make different products in the courses they follow. A lot of attention goes to the design process and the creation of the product. However, when students need to present their product, less attention is paid to the way students should present. This results in an unprofessional exposition of their photographed product.

This report will present the light studio, a solution for students to easily create professional photos by understanding the steps to take to make photographs. During the research phase of the design process, three topics of photography - camera, light and photo editing - were explored. Information about these topics is gained to implement in the concept as an informative part for the students and to develop the concept. From an explorative ideation phase, the final concept of the light studio is presented. This concept is tested with six IDE students who are either experienced with photography or non-experienced. The results gave insights to iterate the concept and give recommendations for further development.

The design process consists of three main parts: research, conceptualisation and further development. First, the research phase starts with defining the problem in chapter 2. Then, the research of photography is done, starting with explaining the studio set-up in chapter 3. Different camera types and functions are explored in chapter 4. Chapter 5 will focus on light and light interaction with products in photography. Photo editing will be explained in chapter 6. The conceptualisation starts in chapter 7 by showing the ideation phase followed by the concept details and a final build prototype in chapter 8. Further development in chapter 9 conducts a user test with IDE students and the redesign is made in chapter 10. The discussion and recommendation in chapter 11 will give the last directions for further development of the concept.

Figure 3, Sketch of the final design of the light studio.

2. PROBLEM DEFINITION

At the faculty of Industrial Design Engineering (IDE) TU Delft, students follow courses in which they learn how to create products. The courses end with presenting this product by making a poster, presentation or with an exposition. The attention in the design process goes mainly to designing the product itself. However, in the final stage when students present their work, there is a lack of attention choosing the right colours and light for the presentation scene. This often results in an unprofessional look and not convey the intended message for their product. An important step in the process of presenting the work is photographing. The main focus for this project will lay on this part.

Current situation vs Desired situation

In the storyboard of Figure 4, the current situation is visible of two students who want to present their product. While doing field research, these problems came to the surface. They are summarised into two scenarios. Both students have different needs and face different problems which are related to photography.

Current situation: Students have to deal with complex theories and information before they can present their products.

Interaction qualities:
- Confusing
- Frustrating
- Missing starting point

Desired situation: Students understand how to deal with colour and light to present their products in a proper way.

Interaction qualities:
- Confident
- Motivated
- Joyful

Design goal

By giving students an understanding of the steps to take in photography, the students will be motivated to present their products in a professional way. This way, the student will enjoy the last step of the design process and feel more confident while photographing and presenting.

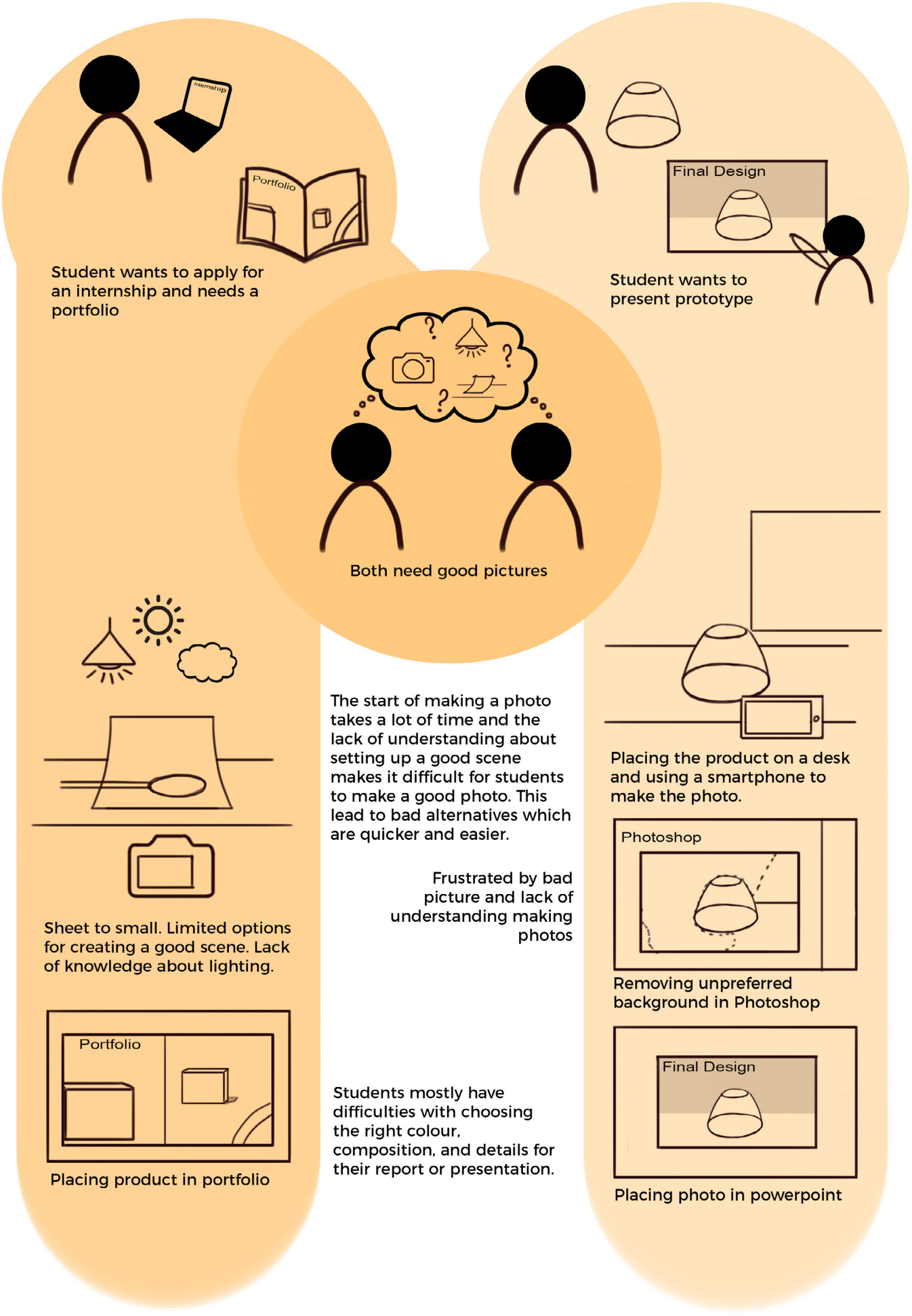


Figure 4, Current situation of students interaction with photography and the problems they face.

Interview

Two interviews were done to locate the problem students face when presenting their product or prototype.

The first interview was with a fourth-year master student. He often makes pictures to present the product created in group projects. Last year, he did an internship for which he needed to make a portfolio.
His first step of making an image of a product is to decide whether he wants to make a 3D digital render or photo. Both are good communication ways. The difference is that a photo can show the real made prototype. When he wants to make a product photo, he uses a white sheet, sunlight and a single-lens reflex camera. Problems he faces when making photos are bad illumination and focus. The camera does not always focus on the right spot, especially with low illumination.
When the photo is made, he usually places the image in a poster or presentation slides. He might adjust the image or remove the background in Photoshop to let it fit in the layout of the poster. When he makes a poster for a product, he makes the colours of the poster coherent to the product colours. Most problems he faces when making a poster, presentation or portfolio is related to the composition. The placement of all the components is crucial to give it a good look and more importantly to create a certain environment in which the product will be used. “I normally start with the background and then fit in all the separated elements.” He also mentions that it is a matter of intuition rather than expertise. He also mentions that it is a matter of intuition rather than expertise. An interesting point. Intuition might help experienced photographers. They have created a feeling for the right composition and lighting. However, when inexperienced students want to make a photograph, knowledge about light placement, composition and cameras, will help them to better communicate the appearance of the product.

During a photography workshop of the course Design Visualisation, I observed and asked several students how they experience photographing. After an informative lecture, students were grouped to make photos with the information they learned. One student brought her own single-lens reflex camera which she knew very well. Everyone in the group was curiously observing while she was operating the camera. I interviewed a third year student who had chosen to follow the course. She did not have experience with photography, so she was really interested. However, she was unsure about making the photos due to a lack of understanding. She mentioned that during projects other group members usually make the photos. When she has to take photos for her own project, she does not know where to start or how to set up the right scene. This becomes visible in her presentations.
This is something I observed in a lot of groups during projects: only one person has a single-reflex camera and knows how to capture nice pictures. The rest of the group members do not try it themselves and thus have no experience for an individual project. This is a frequently occurring problem. In the paragraph Observations, examples of these situations will be given.

Conclusion

The interviews showed that making a good photograph can be challenging for students. There are tools available to help students understand the compositions and colour to use in portfolios and presentations. However, photographing is a difficult topic. Besides all the available information, students need to see, experience and understand how light and composition influence the appearance of the product.

Observation

During different courses in the bachelor and master of Industrial Design, I observed several situations in which students made pictures of their products and prototypes. This paragraph will discuss different examples of these observations.

In a master program project, a student received the task to photograph the mock-up model. She took the pictures in Figure 5 (left) with her smartphone. The photos were used in the presentation beside the renders of the product (Figure 5, right). The difference in presentation is big. The photos show have an unprofessional look, whereas the renders look professional.
While observing, it became clear that the lack of materials available caused a problem when

the student wanted to take the photo. The images were made by improvising a studio with the available materials (a wooden table and lighter wood panel to use as background). Setting up a good studio probably took too much time. Besides, no other lights were used than the lights in the area. From other observations, it can be said that this is normally what happens when students make photos.

Another example is a project in which a student wanted to make an image of an exciting product and reflect on the design. The student worked in a certain room and did not want to leave her stuff. She decided to make the images in the area she was working at that moment. In Figure 6 the image is shown. The composition is informative and materials and their reflections are clear. However, the table was glossy and reflections of the lights above became visible on the picture. Also, the front and inner part of the lid is not visible. Having more knowledge about photography would make it easy for the student to know that a simple light in front of the product would help with a better communication.
Later, the student decided to redo the photo for use in a report (Figure 7). The white background already changed a lot in the appearance of the photo. A problem in this image is the colour. The earbuds should be silver, but appear bronze . One last step she did not make, is to edit the photo in order to get the right silver colour.

These two examples visualize what happens in a lot of projects. The attention in the project goes to designing the product and misses the part of presenting the product in a professional way.

Figure 5, Example pictures of a master student project. On the left side, photos of the mock-up are shown which are of less quality than the rending of the 3D model on the right. It shows the lack of attention to photography among students. (Pons, 2019)

Figure 6, A student has limited options in the workspace to set up a studio, which gives an image with too many reflections and contrast. (Remmerswaal, 2019)

Figure 7, The realization of the reflections and high contrast let the student remake the image. This time with a good composition and brightness. However, the colour is incorrect and could be solved by editing knowledge. (Remmerswaal, 2019)

RESEARCH PHOTOGRAPHY

To get an understanding of the complexity of photography, the photography elements are highlighted and explained. First, some general information for setting up a photo studio is given and the necessary elements are shown. Then, different settings and types of cameras are explained. After that, the focus lies on lighting. What is light and how is it used in photography, are questions that will be answered. Finally, photo editing with Photoshop is explained.

3. STUDIO SET-UP

To photograph a product, a studio is needed to make a photo. A studio consists of four main things: the subject (object/product or person), camera, light, and background, see Figure 8.

3.1. Camera

The camera is placed in front of the subject. In order to get a good focussed photograph, the camera needs to stand on a tripod. To prevent shaking of the camera and unfocused images when pressing the shutter button, the photographer can make use of a remote controller or control the camera via a computer. If there is no access to these options, the self-timer of the camera can be used. Explanation about the camera settings will be given in chapter 4.1.

3.2. Studio light

Setting up a studio can be indoors or outdoors. The variable factor is light, which is coming from artificial light or the sun respectively. Photographing indoors is controllable, which makes it easier than outdoors.
Light and the light sources that can be used for photography will be further explained in chapter 5.

Figure 8, The subject, background, lights, and camera are the most important elements which are needed to set-up a photo studio. (Barratts Photography,w.d.)

3.3. Background

The background is located underneath the subject and curves upwards behind the subject. In this way, no lines will appear behind the subject. White paper can be used for the background. However, ordinary paper has some texture which will become visible in the picture. Using a smooth plastic-like material as background solves this problem, Appendix B (Lenden, 2019).

3.4. Subject

The subject is placed in the middle of the setting, not too close to the background. This will cause the shadows to bend with the curve in the background.
In a lot of pictures, the scale of the subject is not well communicated by the lack of reference. This can be solved by placing something recognizable beside it which is recognizable for the viewer.
There are different ways to do this. Placing something related and recognizable beside or in the subject is a possible way (Figure 9). In Figure 10, the product is placed in a context in which it will probably be used. The book is not only a reference to the size of the product but also a communication for the purpose of the product.

Figure 9, Placing something related to the subject helps to explain the scale. (Target, w.d)

Figure 10, Showing context in an image helps to explain the use. (Finder, w.d.)

4. CAMERA

This chapter will shed light on the different types of cameras and their functions. First, some general knowledge about the functions of a camera will be given to make it easier to understand the differences between the cameras. Then, the different types of camera and lenses will be explained.

4.1. Camera setting

Five main settings need to be understood when using a camera. These are the aperture, shutter speed, ISO, metering mode and autofocus. Aperture, shutter speed and ISO are closely related to each other. When changing one, the others will change too in order to get the right illuminance.

4.1.1 Aperture

The aperture is placed behind the lens of the camera and rotational blades regulates the amount of light that is captured by the sensitive sensor (Figure 11). When the aperture has a small number, it is opened widest and will let more light through. The image will get a smaller focal point which means the photo has a short depth of field. A large number indicates a small aperture which lets less light through (Figure 12). The focal point becomes larger and a longer depth of field becomes visible. (Photographylife, w.d. a).

4.1.2 Shutter speed

The shutter speed is the time in which the light-sensitive sensor is exposed to light. A fast shutter speed will cause less light to reach the sensor. This makes it possible to capture fast-moving subjects. With a slow shutter speed, the light falls on the sensor for a longer time and the picture will be brighter. To make a sharp photo it is important to keep the camera as still as possible, especially with a slow shutter speed.

Figure 11, The aperture blades are placed behind the lens of the camera and determines how much light reaches the sensitive sensor (Feather & the wind, 2018)

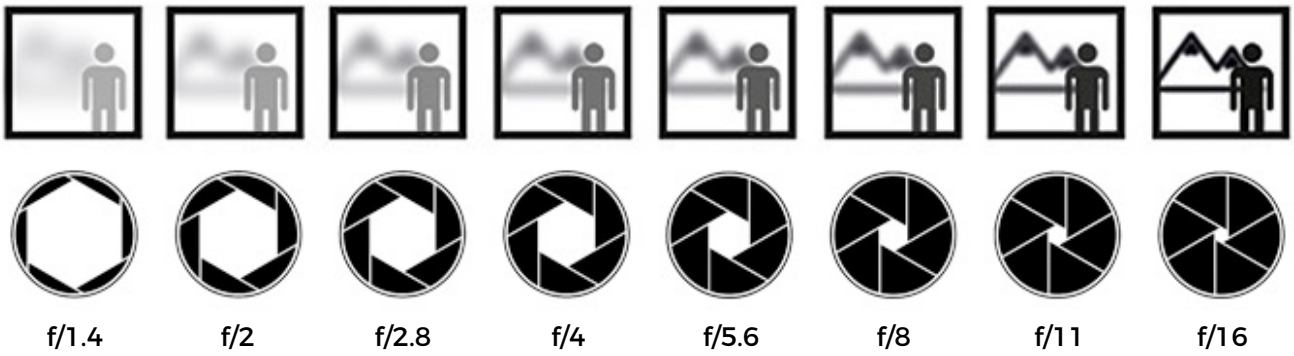


Figure 12, A wide aperture gives high illumination and a small depth of field. A narrow aperture gives low illumination and a wide depth of field. (SLRLounge, w.d. a)

4.1.3 ISO

The ISO setting determines the sensitivity of the sensor. With a high ISO, it is possible to photograph darker environments. However, the picture will have more noise. Noise in a photo is when pixels are randomly coloured and make the scene less clear to read. Vice versa, a low ISO is used in lighter environments and will give less noise and better focussed images. The image on the left in Figure 13 shows less noise and the right more noise.

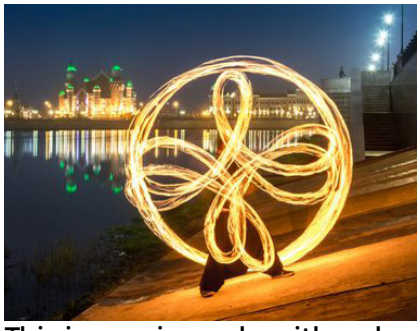
Before making a photograph, the photographer should look at what he wants to create. When the photographer wants a certain point of a product in focus, he uses a large aperture. This will let more light through. Depending on the light of its environment, the shutter speed will be short to make sure the photo will not be too bright.

In another case, the aperture is set to a large number in a dark environment. The shutter speed is set to the highest level, but the image is still too dark. In this case, the ISO will need to be increased.

Figure 13, Noise increases with a higher ISO. (SLRLounge, w.d. a)

This image is made with a small aperture to increase the depth of field and a slow shutter speed to increase the brightness of the image.

A large aperture gives a small depth of field. It allows more light reaching the sensor and it will avoid overexposure, a fast shutter speed is needed.



This image is made with a slow shutter speed to allow capturing a moving object in one image. A large aperture and high ISO are needed to establish a bright image.

To capture fast-moving objects, a fast shutter speed is needed. Light has less time to be exposed to the sensor. To get a brighter image, the aperture is set to a small number.

Figure 14, Connection aperture, shutter speed and ISO. Top left and right (Jlw, 2016), bottom left (Masoner, 2018), bottom right (Newman, 2016)

4.1.4 Metering mode

The camera has different settings; the photographer can decide to set the aperture, shutter speed or ISO himself or to let the camera choose e.g. the right shutter speed with a certain aperture.

The different settings are:
M= Manual – self-regulation of aperture, shutter speed and ISO
A (Nikon) Av (Canon) = Aperture – self-regulation of aperture and ISO. The camera decides the shutter speed
S (Nikon) Tv (Canon) = Shutter speed – self-regulation of shutter speed and ISO. The camera decides the aperture
P = Automatic – Self-regulation of ISO. The camera decides the shutter speed and the aperture

The camera needs to estimate the brightness of the scene when the photographer chooses to let the camera set a certain aperture or shutter speed. This is when the metering mode is used. The metering mode takes an average of the lighter and darker places in the scene and calculates the difference. There are different ways the camera can calculate this average.
One is the matrix (Nikon) or evaluative metering (Canon). In this metering mode, the camera takes all the lighter and darker areas and calculates the average to determine the right settings for the shutter speed and aperture. More specific is the center-weighted metering. In this setting, only the parts around the center are used to calculate the average.
The third metering mode is partial metering and can only be used in Canon cameras. In this mode, the camera takes a small sample of the scene to calculate the brightness.
The last mode is the spot metering. It only uses one specific point to determine the brightness. Through the light meter it is possible to see whether an image is under- or overexposed. (SLR Lounge, 2015) (Photographylife, w.d. c).

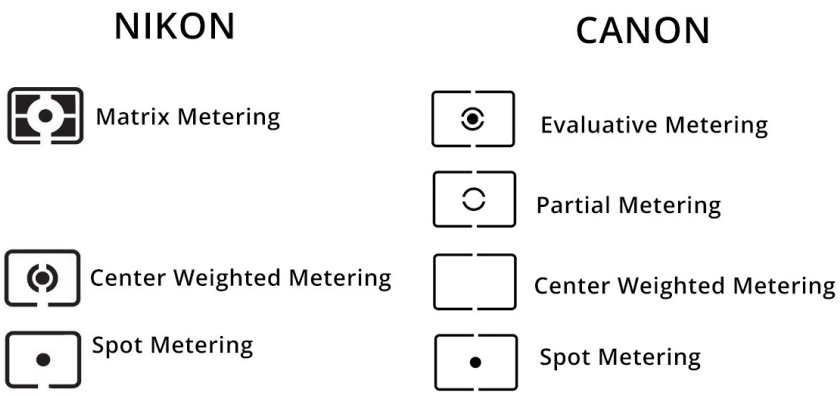


Figure 15, Metering modes of the Nikon and Canon camera. (Coan, 2015)

4.1.5 Autofocus

Autofocus (AF) is the way the camera places the focal point on a subject in the scene. There are two main modes: active and passive autofocus. Active AF uses the red beam and is good for darker environments. It can only be used for static subjects which are close to the camera. The camera uses the red beam to detect the distance between the camera and the subject to determine the focal point. A normal passive AF does not use this function and needs enough light to find the right contrast and focal point in a scene.

The way the AF is functioning depends on the sensors that are used and the aperture.
Two types of focus points sensors are vertical and cross-type sensors. The vertical sensors are only able to detect contrast in one vertical direction. Cross-type sensors are able to detect contrast in a horizontal and vertical direction which makes them more precise in their focus. These two sensors are combined in cameras. The amount of sensors and especially the amount of cross-type sensors indicates the professional quality of a camera.

The aperture is also a big influence because it regulates the amount of light and contrast the camera can detect. A wide opened aperture of f/2.8 works best for focusing as AF works best under high illumination. By closing the aperture, the camera will have problems with focussing in both the active and the passive mode.

The passive and active mode are general modes. A camera has four specific focusing modes which will be discussed for both the Nikon and Canon brand.

The first mode is the Single Area AF/ AF-S (Nikon) or One shot AF (Canon). This mode is useful for a static subject. When the shutter button is pressed half-way, the camera will find the focus on a single point and lock the focal point in a certain plane. The camera will not change the focal point when the subject is moving. It will keep the focal point at the same point and by moving back- or forward the subject might get out of focus. This mode can be used as a passive mode in which focusing in lower illumination is possible.
Another focusing mode is the Continuous / AF-C (Nikon) or AI Servo (Canon) mode. This mode is useful for moving subjects. The camera places the focal point on the subject when the shutter is half-way pressed and when the subject moves, it automatically readjusts the focal point. This active focus mode needs enough illumination to find the focal point in the scene.
An AF-A mode (Nikon) or AI Focus AF (Canon) combines the AF-S and AF-C. The camera detects whether a subject is static and moves into an AF-S mode. It changes the mode to AF-C when the subject or camera is moving. This mode is mostly used for beginning photographers to make focusing easier.
Besides the automatic focus modes, there is also the possibility to adjust the focal point by hand (Figure 17). This is mostly used when the camera cannot find the focal point by low illumination or for macro photography in which the focal point is specific.
(Photographylife, w.d. d)

Figure 16, The three autofocus and manual focus options on the Nikon camera. (Jim, 2015)
AF-S for static subjects and low illumination
AF-C for moving subjects and high illumination
AF-A for automatically choosing AF-A or AF-S
MF for manual focus

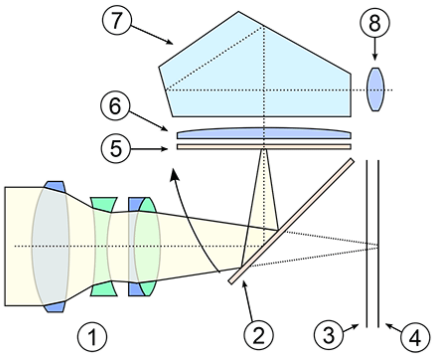
Figure 17, Shifting from autofocus to manual focus can be done by a switch on the lens of the camera. (Discover Digital Photography, 2015)

4.2. Types of cameras

The three types of cameras which will be discussed are Digital Single Lens Reflex (DSLR), System camera and compact camera. All have different functionalities, qualities, and prices.
A DSLR camera (Figure 19) is a typical camera used for professional photography, because the quality of photos is high and it has a viewfinder. The high quality is the degree of sharpness of the photo and the possibility to have less noise in darker environments.
A section of a DSLR camera is shown in Figure 18. Firstly, the light goes through the lens (1) and passes the aperture. A mirror (2) reflects the light to the focusing screen. From here, the light is guided by a pentaprism (7) and becomes visible for the photographer through the viewfinder (8). When the photographer wants to make a photo, he presses the shutter (3). The shutter changes the position of the mirror through lifting and the light falls on the light-sensitive sensor (4). The time the light falls on the sensitive sensor is the shutter speed. The image is captured and translated to the digital screen on the backside of the camera. Most DSLR cameras have the possibility to look on the digital screen when making a photo. In this case, the photographer cannot look through the viewfinder. In this setting, the mirror is lifted and the light is constantly projected on the sensitive sensor and translated to the screen.

The last setting of the DSLR camera is the base for the system camera (Figure 20). The system camera is quite recently introduced and misses the mirror. When the camera has a viewfinder, this gives a digital view. The sensor is constantly exposed to the light and translated to the digital screen. By pressing the shutter, the image that is visible on the screen is captured. The camera is compacter and lighter than the DSLR because the mirror is missing. Nowadays, the system camera is comparable to the DSLR considering its quality and functions. The main loss with a DSLR is the slower focus, especially in darker environments.
The quality of both cameras is the same because of the same sensor sizes which will be explained later.

Another type of camera is a compact camera (Figure 21). Compared to the DSLR and system camera, the compact camera is small and easy to take when traveling but has lower-quality photos due to the small sensor and no possibility of changing the lenses. Most compact cameras do not have a viewfinder and the focal length is small. This can create a deformed appearance of the images. This camera is generally used for personal use and not professional work. The principle of making photos in a digital way is the same as the system camera.



1. Lens
2. Reflex Mirror
3. Shutter
4. Image Sensor
5. Focusing Screen
6. Condenser Lens
7. Pentaprism
8. Viewfinder

Figure 18, Section of a Single Lens Reflex camera. (Photographylife, w.d. b)

4.2.1 Full frame vs cropped sensor

Every camera has a sensor which captures the scene. These sensors can change in size in order to fit in the camera. The different sizes are called full frame sensor or cropped sensor. Depending on the size, the images appear differently. A full frame camera has a wider view than a cropped sensor camera. The image of the cropped sensor camera will be cropped by a specific factor.
In the example of Figure 22, a photo is made of a cube with a full frame camera and a 50 mm lens. The second photo is made with a cropped sensor camera and the same 50 mm lens. The photo is a cropped version of the full frame camera photo. The crop factor is introduced to work with the different sizes of the sensors. To get the same image with the different sensors, it is possible to change the lenses. If the crop factor of a sensor is 1.5, the lens that is needed is 50/1,5 = 33,3 mm. So, a 35 mm lens is used to receive the same image.

Although the size is similar, images will show some differences. With the full frame camera, the image will have a larger depth of field and the image appears brighter than the cropped camera. The bigger the focal point of the lens, the larger the depth of field becomes. Also, the 50 mm lens receives more light than the 35mm lens. To get an equal brightness of the images, it is possible to set the ISO of the cropped camera to a high number, enlarge the aperture or change the shutter speed.

Besides the advantage that a cropped sensor camera is smaller and lighter in weight, photographers face some problems with the cropped sensor camera. To create the same image as the full frame camera, the camera needs to be set to a small focal point and a high ISO to get the right brightness. However, the image will have more noise. The limitation of a cropped sensor becomes clear when the existing lenses cannot achieve the same depth of field and quality as the full frame camera. It cannot receive enough light through the lens. (SLRLounge, w.d.)
Besides, the 35 mm lens is a wide angled lens. This will change perspectives in the image. The combination of the full frame and 50 mm lens gives the view as the human eyes. Using other combinations will lead to deformation of the real scene.
It is a matter of choice depending on the purpose of photographing to choose for the quality of a full frame camera.

Figure 19, Full frame Digital Single Lens Reflex (DSLR) camera. (Kamera-express, w.d. a)

Figure 20, Full frame System camera. (Kamera-express, w.d. b)

Figure 21, Cropped frame compact camera. (Kamera-express, w.d. c)

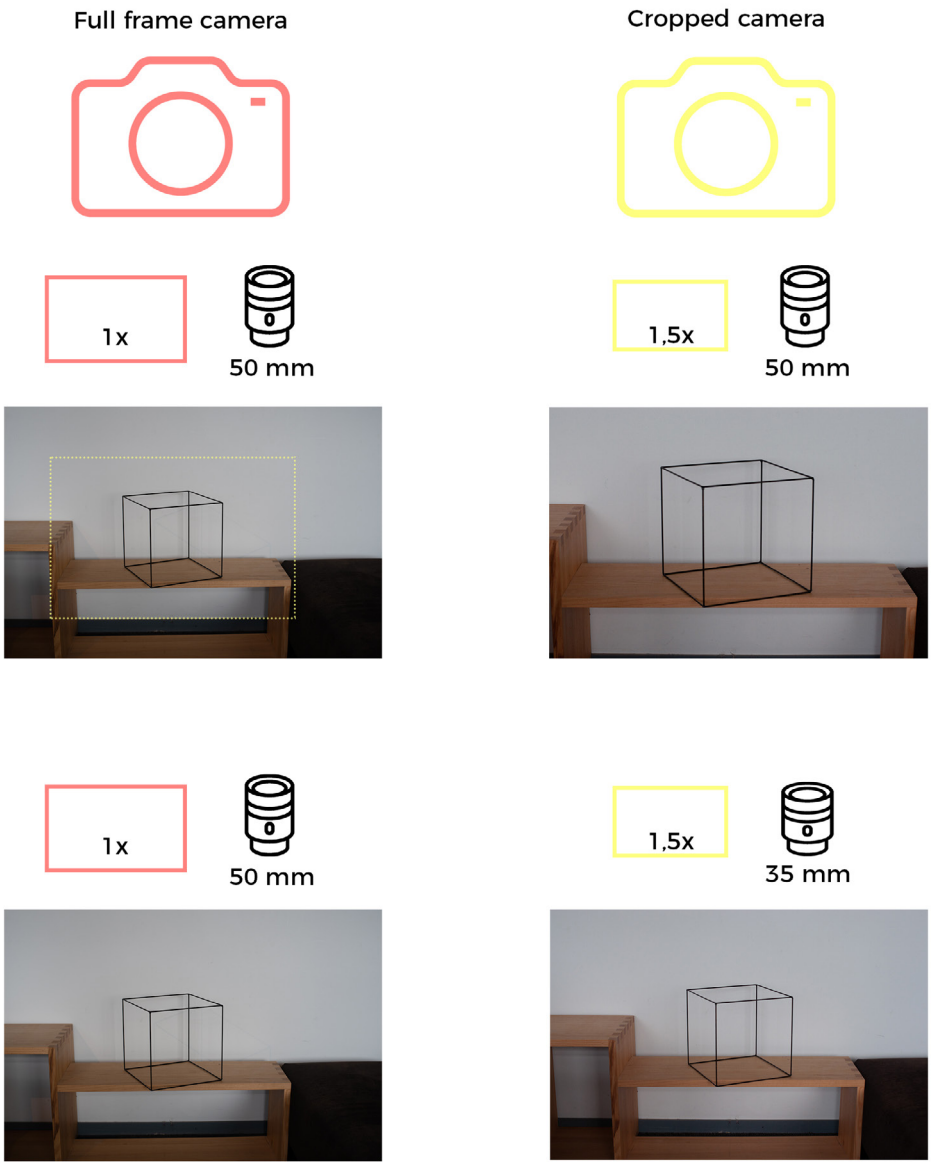


Figure 22, An image of a cropped sensor camera compared with an image with the same lens on a full frame camera is cropped by a factor 1.5. Dividing the lens size by the factor will give the same image frame.

Summary

The first part of the photography research started with the understanding of the camera, the different types and its functions.

A camera has five main settings: the aperture, shutter speed, ISO, metering mode and autofocus. The photographer can determine the depth of field with the aperture, the time the sensor is exposed to the light by the shutter speed, and the sensitivity of the sensor by the ISO. These three settings are related to each other. When for example a small depth of field is preferred, the shutter speeds will be high to prevent overexposure of the image.

Metering helps in estimating the brightness of a scene and autofocus with capturing a subject in focus in different ways.
Besides these settings, there are also different types of cameras with their own properties. Depending on the purpose of use, the right type of camera can be found.

5. LIGHT

Light in photography determines significantly how the appearance of the subject is visualized and what message is given to the observer. Because many different shapes, materials and colours exist, every subject needs to be examined differently.
This chapter will explain the basics of light and will give guidelines on how to enlighten a photography scene correctly.
This will enable the photographer to combine the knowledge and translate this into a good photo lighting set-up.

5.1 Light explained

Small bundles of energy, called photons, travel through space and together create electromagnetic radiation. They all have the same speed, but a different frequency.
In Figure 23, two photons are shown with different wavelengths. Photons with a wavelength between 380 and 780 fall in the part of the electromagnetic spectrum that is visible for humans and is called light. The differences in energy let us see colours. Every colour is created by a certain type of frequency. Blue e.g. has a shorter wavelength than red (Rossotti, 1985).
In Appendix A the human visual system and its perception of colour is further explained.

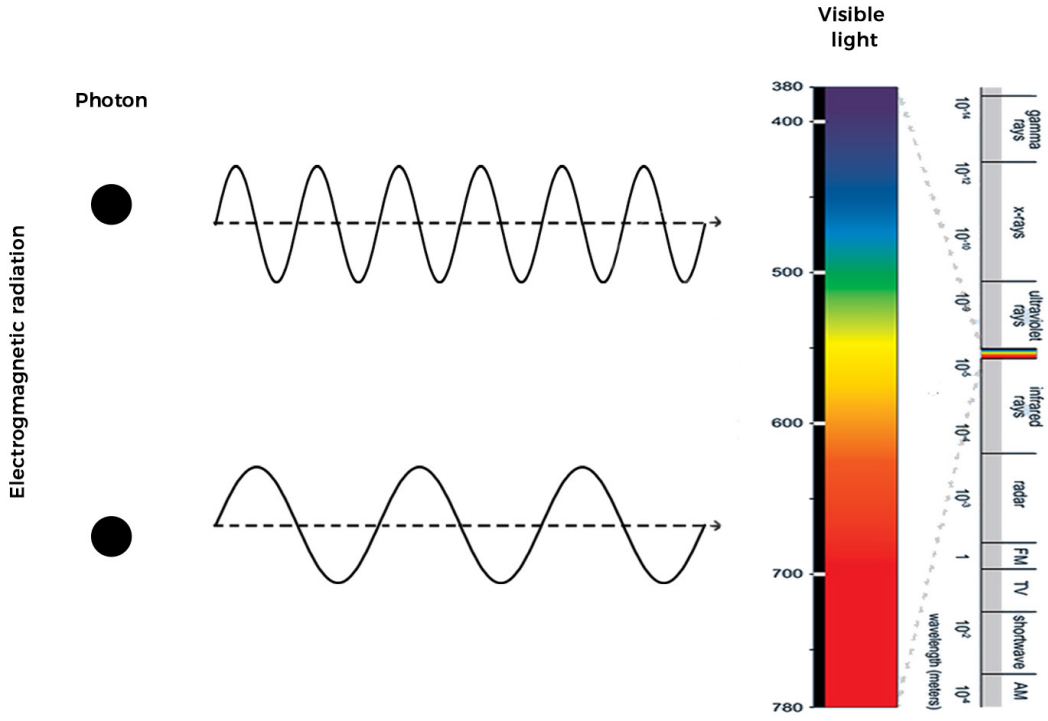


Figure 23, Photons travel through space with the same speed, but a different frequency. The photons with a wavelength between 380 and 780 fall in the visible spectrum of the human eyes.

5.1.1 Ambient, focus and brillance light

There are three types of light that will be discussed.

Light coming directly from the sun is called focus light. This unidirectional collimated light creates high contrast on an subject by dark form and cast shadows. (Frandsen, 1987)

An ambient light can be created by clouds. Focus light is scattered and reaches the subject from spherical directions in an equal amount of illumination. No shadows will appear which causes the lack of three-dimentional shape and the lack of communication of the texture. Ambient light is perfect for communicating the colour of a subject by the low contrast. (Zhang et al., 2015)

Combining these two lights creates shadows on the subject with little contrast. The combination of these lights is called brilliance light. An amount of smaller lights is used to create the effect. (Zhang et al., 2019)

Further explanation about light interactions with materials and shapes will be discussed in chapter 5.3.

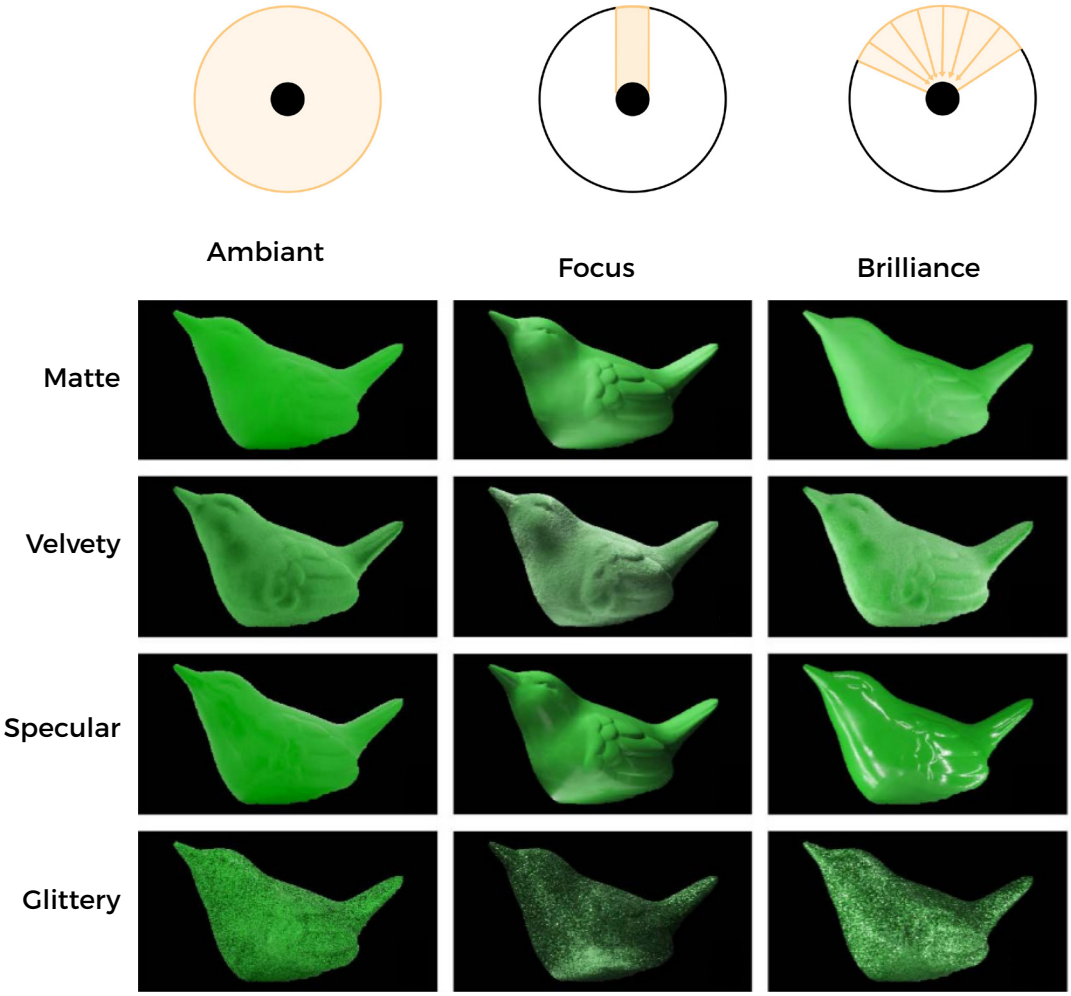


Figure 24, From a research of Zhang et al. (2019), 12 images of birds are made under different light and material conditions. From left to right, three light conditions (ambient, focus and brilliance lighting) are used. From top to bottom, four canonical materials (matte, velvety, specular and glittery) are shown.

5.1.2 Colour and colour temperature of light source

There are two main light categories: natural and artificial.
Natural light is the light of the sun or fire. This light can change by its surroundings through reflection, absorption and transmission.
These changes are described by the colour temperature. When sunlight travels through clouds, photons with less energy will be absorbed. This causes the light to appear more blue and have a colder temperature. The temperature is described in Kelvin (K). Warm light of a candle is around 1500 K and the light on a cloudy day is 6500 K, Figure 25.

A standard temperature used in photography lamps is called 'daylight' and has a value of 5000/5500 K (Karlen, 2012). By editing a photo, chapter 6, the colour temperature can be changed using the white balance.

Artificial light is light created by electricity.
It can give light in two ways: white light and coloured light. White light is created by the electromagnetic field of the visible spectrum, chapter 5.1.
Coloured artificial light sources work with three primary colours: red, green and blue. Through additive mixing (Appendix A), the light source combines the three colours and thus creates all colours of the visible spectrum.

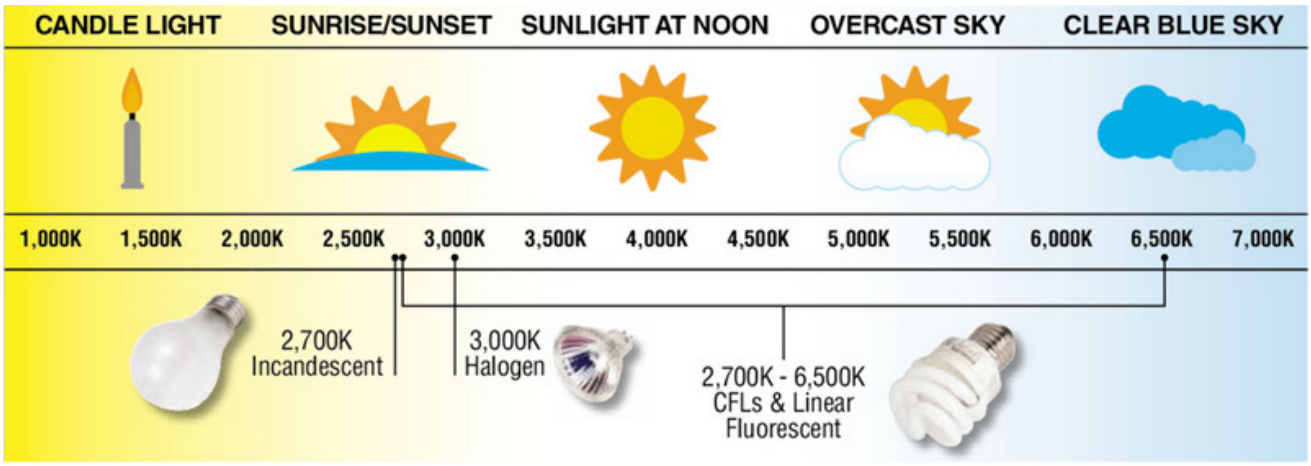


Figure 25, Colour temperature of light in Kelvin (K). A warm (low) temperature makes the environment more yellow and a cold (high) temperature makes the environment more blue. (Brandon, w.d.)

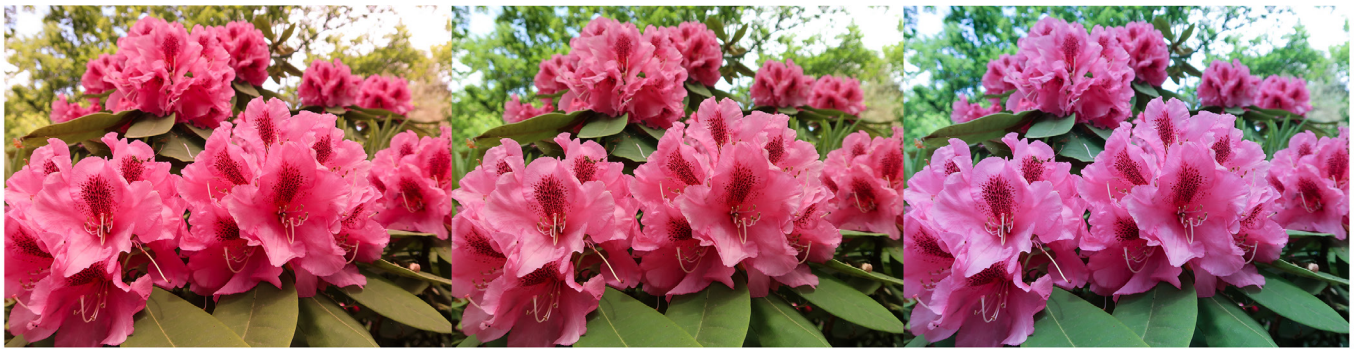


Figure 26, Colour temperature in photography. Left shows a warm (low) temperature and this becomes colder (higher) to the right.

5.2 Lighting in photography

This chapter gives insight in the different types of lighting in photography. With every picture, the photographer should consider the message he wants to convey in order to know the right use of a certain type of lamp. These different types of lamps will be explained.

5.2.1 Type of lighting

In an interview with Thomas Lenden, product photographer of NPK design, information about the light in studio photography is gained (Appendix B). In a normal setting of product photography he uses two main lights: key light and fill light (Figure 27). The key light is the main light that will determine the casted shadow. It gives a high level of luminance and creates a high-contrast on the scene. The fill light is placed on the other side of the product, or above to light up the darker places at the backside of the subject. It is possible to add a third layer, the back light, although this is only used in few cases. A backlight can be used e.g. for a product of soft material like the fibers of fur. This texture needs to be highlighted, which can be done with a light placed behind the subject (Hicks, 1999). Also, the backlight can be placed more to the side and to light up the darker places on the subject which are not lit up with the two base lights.
Besides these three lights, Lenden has placed one other light underneath the product. This fourth light creates a backlight as well and removes the cast shadow of the product. This backlight is only used for very specific cases. The lights Lenden uses are flashlights. First, the lights gives a low illumination to see a preview of the scene. When the shutter is pressed, the lights give their flashlight with high illumination around a light temperature of 5000/5500 Kelvin.

Different elements can be placed in front of the light source to make the product specific. Figure 28 shows the different lights that are available. Lenden mostly uses a softbox. The softbox makes the light diffuse and shadows will appear softer and lighter compared to a normal light source. Also, the colour will be better communicated by the low contrast on the subject and this makes the softbox clear and informative.

Besides the softbox, Lenden sometimes uses a grid. The light rays of the grid are parallel to each other. A normal light without grid tend to spread out the light rays. The grid will give more focus to one point and gives a high contrast. It can give a good indication of textures.

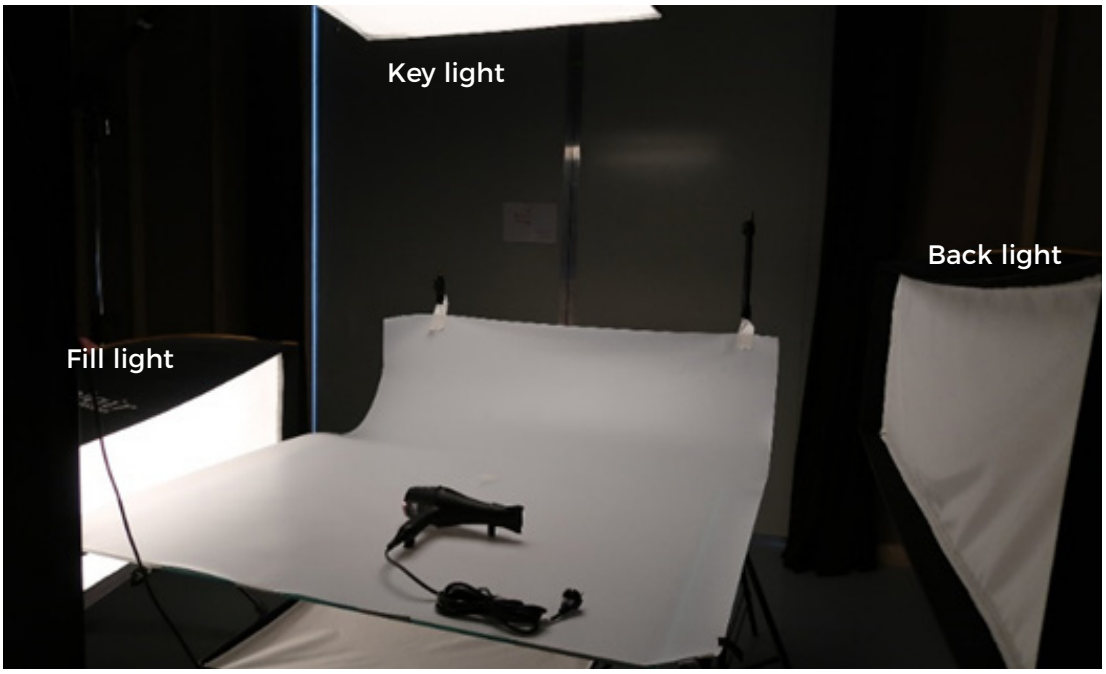


Figure 27, Studio lights of NPK photographer T. Lenden. The key light is the main light which creates the cast shadow of the product. The fill light lights up the darker areas of the subject and will decrease the contrast. A backlight is only used in specific cases which need more light from the back, like fibers of fur.

Other available lamps are light bars, spots, and ring flashes. (Hensel, w.d.)
With a light bar, the light is more divided on the complete subject. This can be useful when the light is placed closer to the subject and a spotlight is not preferred. There are also softboxes with a long horizontal distance to make the light surface larger.
Spots give a single narrowed and rounded light on the subject. It can be compared to light with a grid, however, there is a difference in the appearance of the light edges. In Figure 26, the difference can be seen.
Ring flashes are rounded lamps that divide the light evenly on the subject. It is often used in portrait photography and placed in front of the subject.
Tools that can be used for photographing are reflection screens, placed behind the object. They mostly fulfil the job of the fill light. By reflecting the key light on the subject it can be enough to brighten the darker shadow. A reflection screen can be useful to soften the hard shadow creation by the use of normal light.

5.2.2 Colour Rendering Index

For communicating the quality of a lamp, the Colour Rendering Index (CRI) is used.

The CRI explains how well a light communicates the colour of a subject. The value of the CRI is between 0 and 100 %.
The CRI is different for every light category. Sunlight which has a value of 100 CRI is not comparable with a LED or fluoresce with a CRI of 100 %. The LED is of high quality in its own light range. The CRI for LED light is preferably above 85% in product photography. (DIYPhotography, 2015)

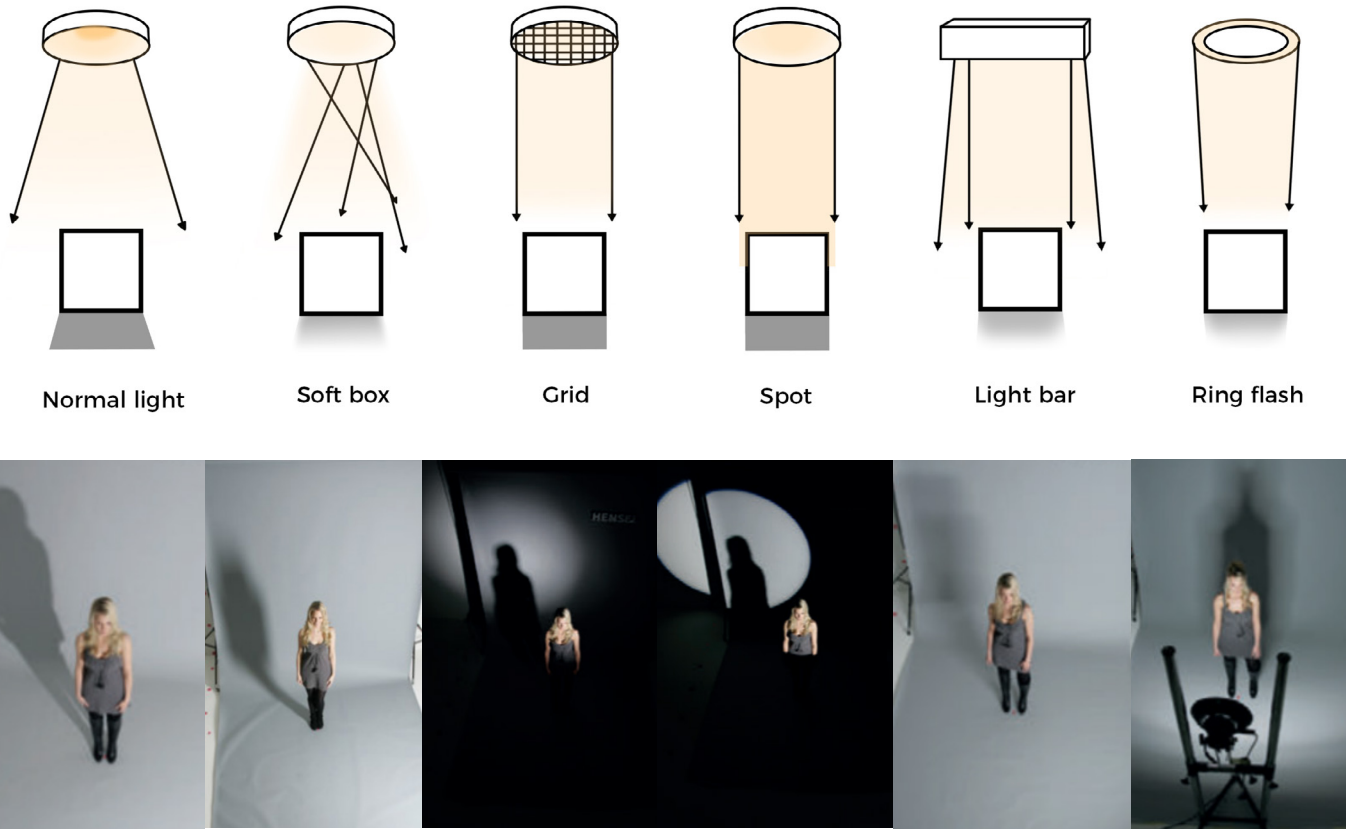


Figure 28, Diffent types of lighting. From left to right: Normal lamp, lamp with softbox, lamp with grid, spot light, light bar, ring flas. (Hessel, w.d.)

5.3. Light interactions with materials and shapes

5.3.1 Reflection, absorption and transmission

Photons can be reflected, absorbed and transmitted by a subject, Figure 29. Photons that strike a reflective surface will bounce off. The way the photons are reflected can explain a lot about the shape, texture and colour of a material.

Rossotti (1985) explains that transmission happens when light is passing through a surface. Air and glass are common materials that transmit light. When light rays shine perpendicular to a transmitting surface, this surface will be invisible. However, when the light strikes the surface with an angle, refraction will occur. In this type of transmission, light rays bend when they are transmitted from one material to another. Every transparent material refracts light in a different way. For example, the refraction of air is smaller than water or glass. Refraction is visible and can be photographed.

It makes it possible to explain the shape of glass and other transparent materials.
Besides transparent materials, there are also translucent materials. They also transmit light, only in a different way. When light rays strike a translucent material, this material will transmit the rays randomly, called diffuse transmission. Placing a translucent material in front of a light source will give a diffuse light on the subject (Rossotti, 1985). A softbox, chapter 5.2, is based on this principle.
Translucent subjects need little attention when photographing and do not need special lighting, because they absorb, reflect and transmit the light.

Absorbed light is not visible. It only becomes visible with reflected light in its surrounding. For example, black only becomes visible when there is a white or coloured surface beside it that reflects the light. Light that is absorbed is converted to heat.

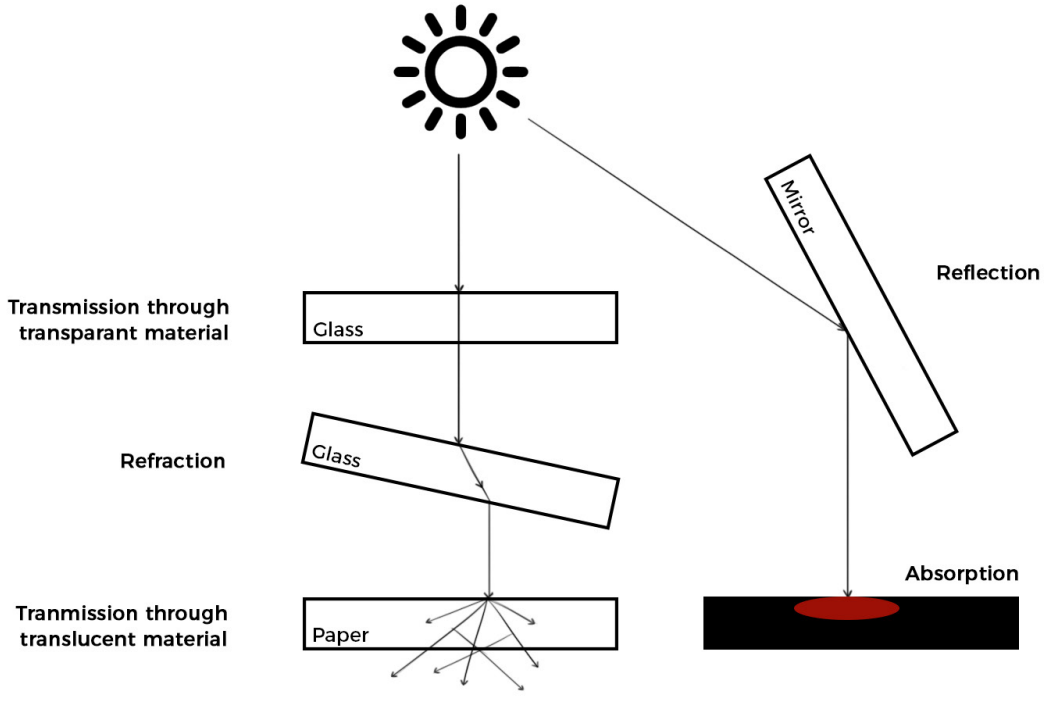


Figure 29. Light transmission through a material can change the direction of the light rays. Transparent material will let the light go through and do not change the colour or brightness. Translucent material creates a diffuse transmission. Specular material reflects the light and opaque material absorbs light which creates heat.

5.3.2 Placement of light in photography

The placement of the light and camera depends on the reflection of the light into the camera. In this chapter, we assume that the camera is fixed and the light can be placed in a wide range of angles and distances.

According to Hunter (2007), there are three types of reflections: diffuse reflection, direct reflection, and polarized reflection. Every surface reflects a certain amount of the three types of reflected light and thus the appearance is different.

With diffuse reflection, the reflected light will bounce off equally in all directions. In the photograph, the different light angles will give the same brightness of the surface. Bringing the light closer to the subject will give a brighter reflection. This type of reflection will happen on matte materials. The diffuseness of the light source does not affect the diffuseness of the reflection.

Direct reflection, also called specular reflection, is when light is bounced off in a single direction. This happens with polished surfaces. Only at one specific point, the bright reflection becomes visible for the camera. The angle with which the light strikes a surface is also the angle with which the light is reflected. Note that only perfectly bright polished materials like glass, water, metal or mirrors will give a direct reflection.

Glossy materials give polarized direct reflection (or glare). It looks like a direct reflection but the brightness of the reflection is dimmed. When light strikes the reflecting surface, the photons lose part of their energy. First, they vibrate in all directions. After striking the surface they only move in one direction, Figure 30. Polarized reflection mostly appears on glossy surfaces, where some diffuse reflection will appear too (Figure 32). Black and transparent surfaces are more likely to reflect polarized light. Some polarized reflection will also appear on matte surfaces.

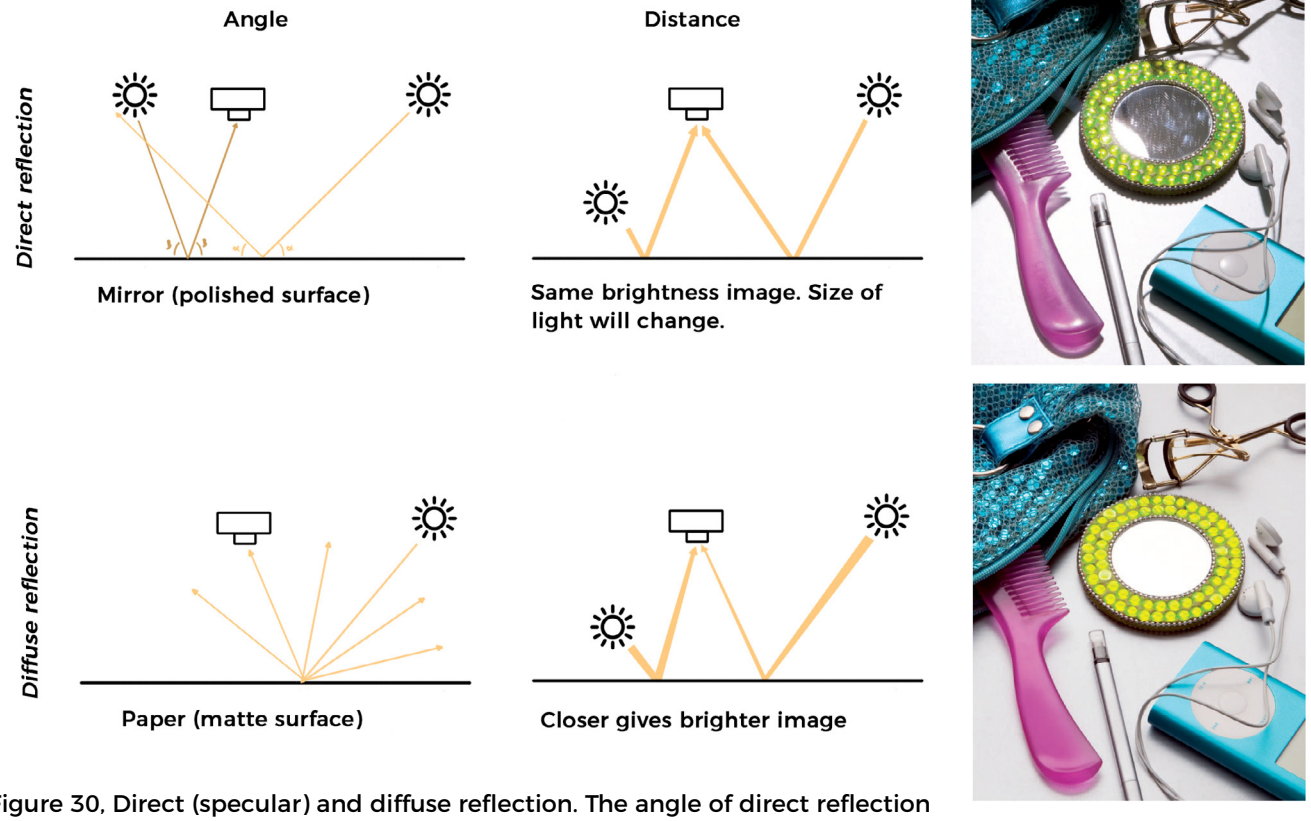
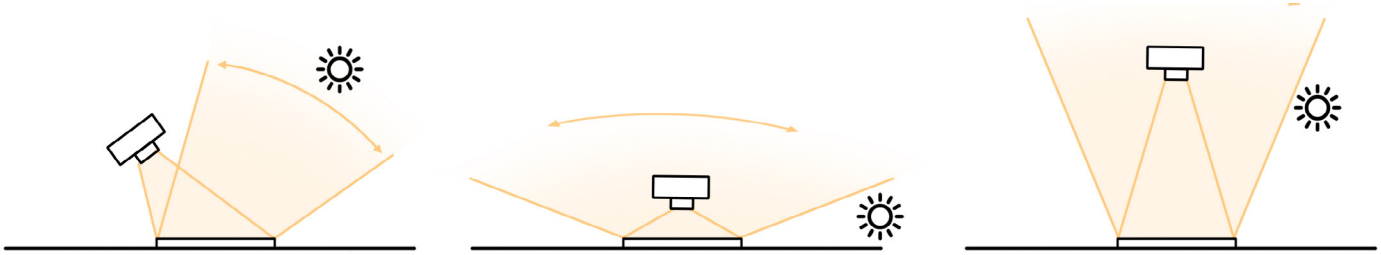


Figure 30, Direct (specular) and diffuse reflection. The angle of direct reflection is equal and does not lose its brightness. Diffuse reflection reflects the light equally in all directions. The brightness of reflection decreases with a light placed further away. (Two right images (Hunter, 2007))

It is possible to determine the placement of the light in order to see the reflective light on the picture. This range is called the family of angles. In Figure 31, an example is given for the placement of a light source in the family of angles. When the subject needs a highlight on a specific place, it is possible to look at the family of angles and determine the placement of the light.
In some cases, it is not preferred that the reflected light is visible. Then, it is possible to place the light outside the family of angles.
The glossy surface will only reflect diffuse reflections. Some problems can occur when the camera is placed close to the subject. The light should be placed very low in order to get no reflection. However, in most cases, the lighting on a product is better from a higher angle. When placing the camera further from the subject, the light gets more freedom to move upwards. (Hunter, 2007)

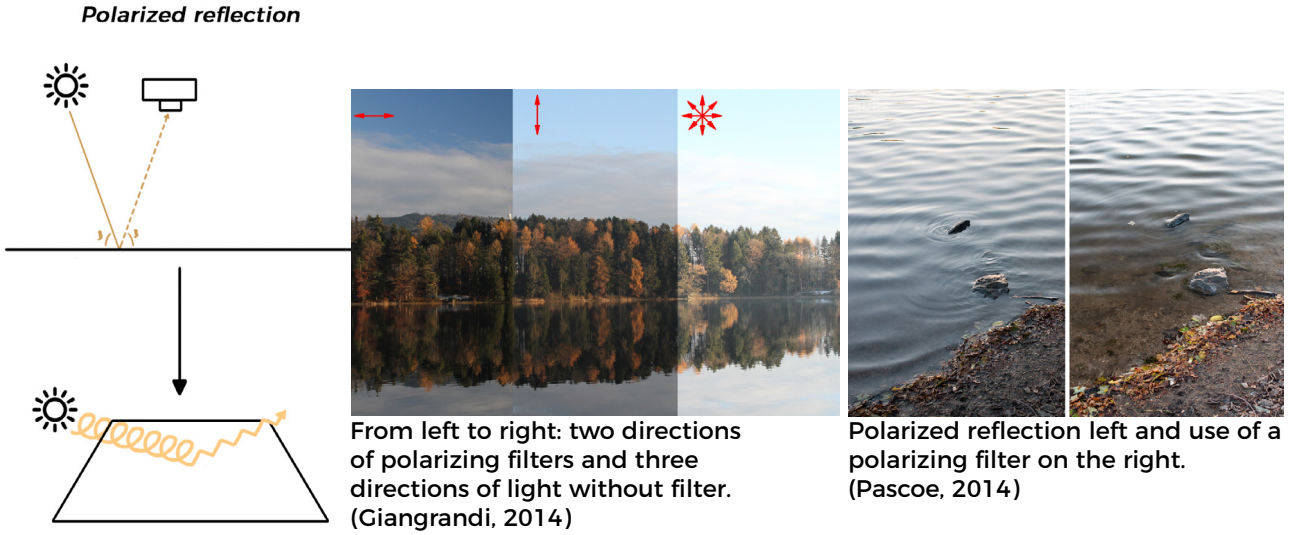


A light placed in the family of angles which reflect on a specular surface, will be visible for the camera.

If the light is not allowed to be visible, it can be placed out of the family of angles. A low placement gives little freedom of movement of the light.

Placing the camera further away from the subject will increase the freedom of movement of the light.

Figure 31, Family of angles



From left to right: two directions of polarizing filters and three directions of light without filter. (Giangrandi, 2014)

Polarized reflection left and use of a polarizing filter on the right. (Pascoe, 2014)

Figure 32, A light source gives light in three directions. Polarized reflective surfaces only reflect the light in one direction. When using a polarizing filter, which allows light in one specific direction to go through, the polarized reflection in the opposite direction will not be visible on the image.

5.3.3 Contrast and shadow

Where there is light and an object, there is always a creation of contrast. Contrast is created by the shadows of an object. When light rays strike an object from a single direction, it will give a high-contrast. The sun is an example of a high-contrast setting. (Xia et al., 2017). A high-contrast source can be recognized by a dark shadow on the ground with sharp edges, also called hard shadows (Figure 33).
When the light rays of the sun are scattered by clouds, a low-contrast light will appear. With a low-contrast, the shadow is less defined and more soft in its appearance.
In general, a hard shadow communicates the shape of a product more efficiently. However, it often creates dark to black parts in the product in which definition disappears. Therefore, photographers usually prefer a soft shadow.

Contrast is not only created on the ground, but also on the product itself. The point where the light rays are directly reflected, appear much brighter than the shadow side of the object. Reflections appear differently on different shapes and materials, chapter 5.3.4. When there is a high-contrast, the colour of an object can appear white and black on opposite sides. With low-contrast the intensity of the white and black spots will decrease and the colour of the object becomes more visible. (Zhang et al., 2019)

Figure 33, The left image is made with a direct light which creates high-contrast. The right image is made with a soft light which creates low-contrast. (Wagner, w.d)

The size and distance of the light also influence the shape of a shadow.
Until now, the focus has been on the angle in which the light is placed. Besides the angle, the distance to the subject is also an important part to look at. The closer the light is placed to a diffuse reflective object, the brighter the object will appear. Besides the brightness, the light shape and distance have a big influence on the shape of the shadow. (Hicks & Schultz, 1999)
When a normal light is placed close to a subject, the shadow will have a wide shape. Placing it backwards, the shape will narrow down to an equal size of the subject, Figure 34. However, it is not always possible to place the light further away from the subject to narrow down the shadow or decrease the light intensity. Therefore, it is possible to use different shaped lights. In Figure 35, three types of lights are shown to give an understanding of how different types of lights create different types of shadow shapes. A light bar has parallel light rays and will give an equal size of the subject and the shadow. If the light bar is bended, the shadow will be narrowed.
For product photography, the most informative light is preferred. A shadow that is proportional to the product will give the best information. Therefore, the best light to use is a light bar or a normal light placed not to close to the subject.

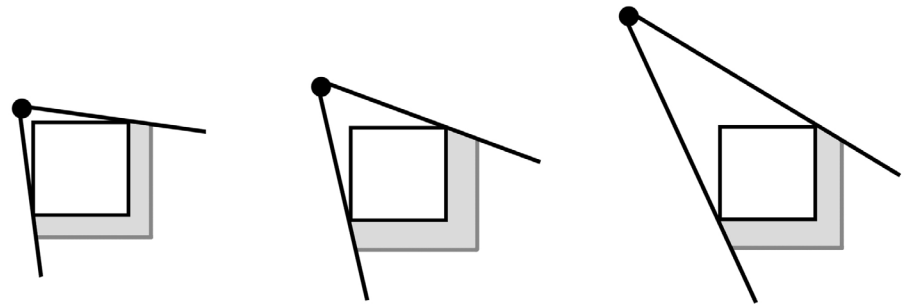


Figure 34, Shadows with normal light. Placing the light further away from the subject gives a better shadow in perspective of the product.

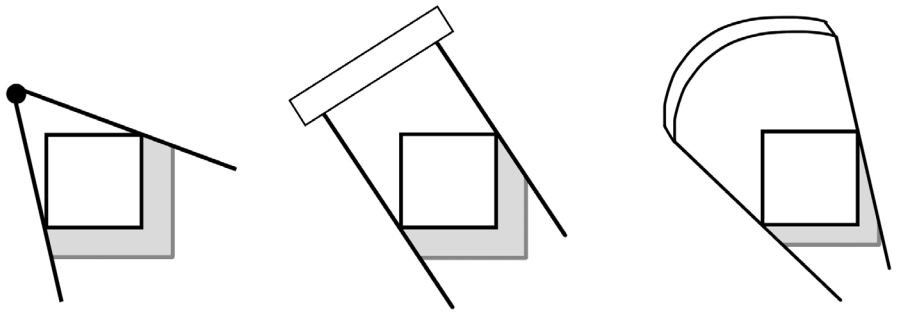


Figure 35, Shadows with normal light, light bar and bended light. A light bar gives the most informative shadow without deformation.

5.3.4 Material, shape and colour communication

In this chapter, the light interaction with canonical materials, shapes, and colours will be discussed. The information provided will be used in the concept and will already refer to how the student will receive the information.

Material

Communicating material is an important part of photography. Fleming, Wiebel & Gegenfurtner (2013) describes ten material classifications: fabric, foliage, glass, leather, metal, paper, plastic, stone, water, and wood.
All these materials have a different perception of qualities like transparency, roughness and coldness. However, the surface structure has similarities and can be placed in canonical materials categories. Four canonical material appearances are specular, matte, glitter and velvet. (Zhang, de Ridder & Pont, 2018). These four canonical material have different scattering modes which will be discussed.
The canonical materials will be used in the interface to explain how the student should place the light in order to communicate the material well.

Specular

A specular material creates a direct reflection. Highly glossy material will reflect all elements in its surrounding. When hard reflections are not desired, a softbox can be used. Besides, the light can be placed outside the family of angles so the direct light will not be visible on the subject.

A chrome material can be placed in the specular material category. However, this material is more challenging than a general specular product. Chromium behaves as a mirror and reflects every detail of its surroundings. Product photographers like Lenden (2019) use after editing to remove undesired reflected elements. This is very time-consuming and therefore it is advised to prevent as much as possible undesired reflections by placing the product in a completely white covered studio.

Matte

Matte materials scatter the light diffusely, resulting in smooth shady gradients. Some matte surfaces have a clear texture which might be important to communicate. In this case the light should strike the surface of the subject. This will increase the texture contrast and create form shadows in the structure. Also, a backlight can be used to highlight the contour and thus the material properties.

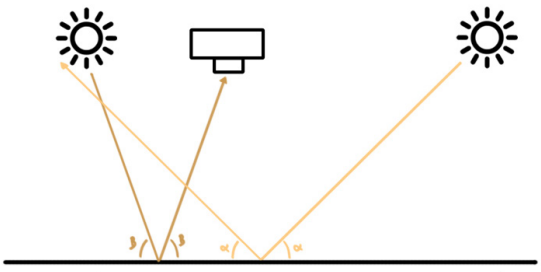


Figure 36, Direct reflection of a specular material

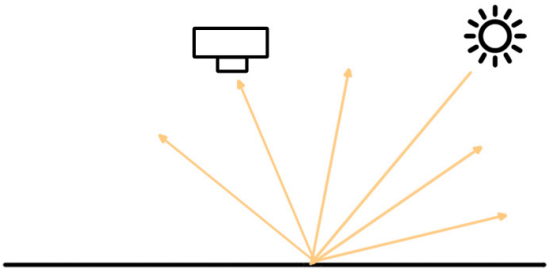


Figure 37, Diffuse reflection of a matte material

Glittery
The perception of matte and specular materials is intensively studied. However, less is known about the materials such as glittery and velvety. (Zhang, de Ridder, Fleming & Pont, 2016)
Glittery consists of tiny fragments which have specular properties which give direct reflections. A glittery material is easy to separate from other canonical materials by its specific small reflections over the entire body (Figure 38).
Because of its specular properties, it is best to use direct light. Direct light can be used when more contrast and stronger highlights are preferred.

Velvety
Velvety is a material which have interesting reflections. On the velvety surface, scattering and asperity scattering occurs. This type of scattering occurs when a surface is covered with hairs. The projected light on the surface scatters between the hairs. This becomes visible as a bright contour. It is best to use a direct light on a velvety surface to receive more reflection of the material and to make it more informative for the observer. Softening the light will make the material less readable. (Barati, Karana, Sekulovski, & Pont, 2015)

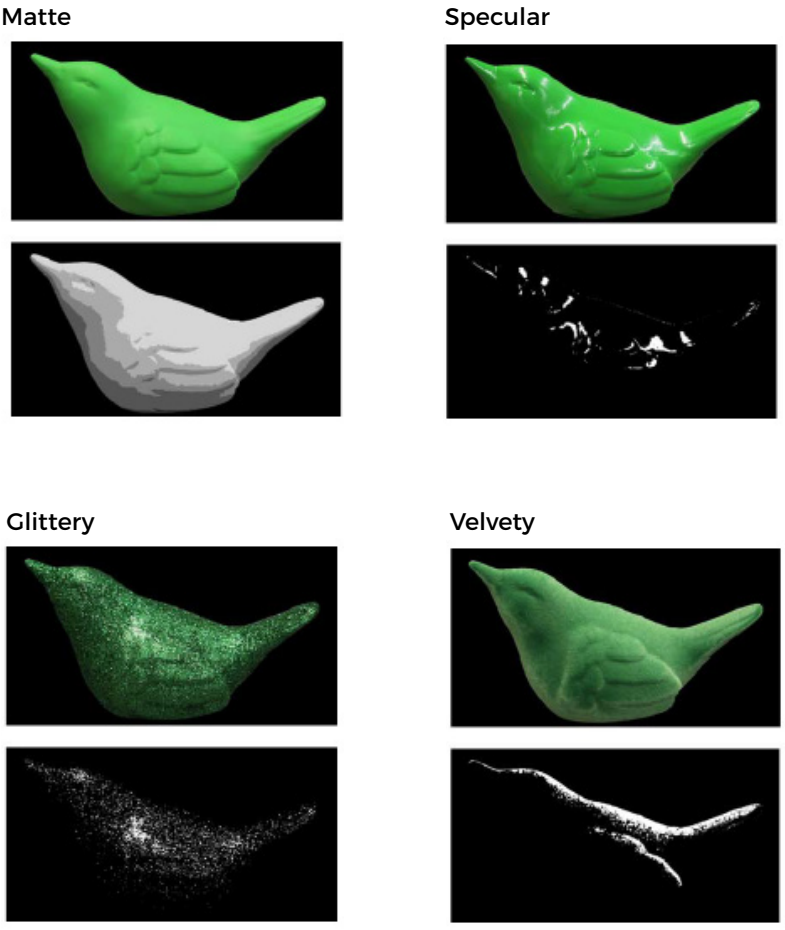


Figure 38, In a material research done by (Zhang, et al., 2016), four birds with the canonical materials were photographed. On top, the colour and reflections are visible. The bottom image shows only the reflection of each material.

Shape

There are three canonical shapes that will be discussed. These are a cube, cylinder, and sphere. The cube is created by flat surfaces which create edges. The cylinder is a single curved surface with on each side a flat surface and the sphere is a double curved surface which also visualizes organic shapes. Every product can be classified in one of these three shape categories and in this way, it is possible to understand how to photograph a certain shape.

Cube

A cube shape becomes visible on an image when there is a difference in brightness between the surfaces. This is shown in Figure 39. When there is no difference between the surfaces, the depth of the shape disappears. Also, the student should understand the communicative direction. A frontal viewpoint will not communicate the shape, as well as a viewpoint, in which all surfaces are visible. Distortion of the perspective by a wide angled lens becomes well visible in a cube shape because it has clear perspective lines. Using a full frame camera with a 50 mm lens (chapter 4.2.1) will give the closest perspective of a human eye. This can also be achieved by a cropped sensor camera and a 35 mm lens.

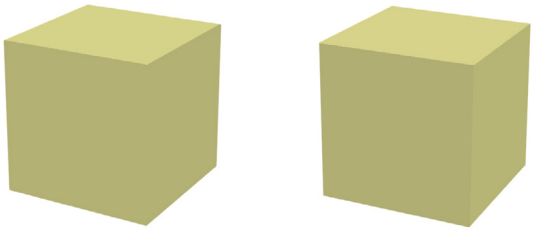


Figure 39, The cube on the left lacks contrast between the surfaces and becomes less readable than the right cube.

Cylinder

A cylinder has a single rounded surface. When the product has a relatively long length, it is preferred to have a longer light reflection. One of the products Lenden (2019) showed in his interview was a bicycle frame (Figure 40). The frame has a cylindrical shape and needs a reflection over the entire body. To achieve this he used a long light in a vertical direction to receive an equal bright reflection on the frame.

Figure 40, A long light is used for the cylindrical shape of the bicycle frame to create an equal reflection. (npk.photography, 2018)

Sphere

The last canonical shape is the spherical or organic shape. These shapes have double curved surfaces and need some more attention. Every product with a double curved surface is different and therefore it is not possible to give one advice for every product. A photographer needs to understand the shape and find a right light placement for the best communication. The examples will help to understand where to look at.

In the spherical shape, the reflections and shadows are very important. They explain the curvature of the surface. The example product in Figure 41 shows the curvature by a reflection which is visible on the top right part. The reflection follows the curve of the front surface and the observer can understand the shape of the front part.

Figure 41, This organic shape needs a reflection to let the observer understand the curves of the chair. (Nellie, 2018).

Colour

When it is important to communicate the colour of a subject, the contrast created by the lights should be low. This can be achieved by diffuse light from all directions. It prevents dark form shadows and less informative colour perception (Figure 42).

Students need to be aware of the colour difference between computer screens and the final photo print. The differences can be big when the computer screen is not calibrated to real life colours. One way to prevent this different is by using a colour passport or grey-card (Figure 43). These have fixed values which are recognized by after editing programs and apply the right colour temperature to the photo. Chapter 6 explains how to use the grey-card in Photoshop. More in-depth information about colour perception can be found in appendix A.

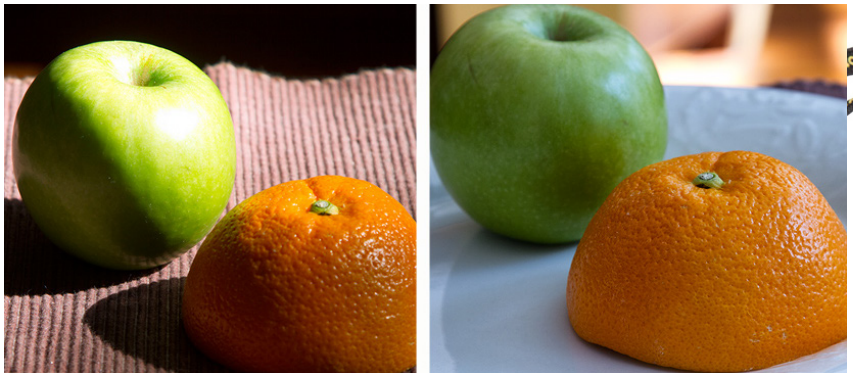


Figure 42, Direct light (left) creates dark form shadows and a high contrast. Using a diffuse light (right) it will give a more informative colour perception. (Schmautz, 2013)

Figure 43, A colour passport consists of fixed colours which are recognized by editing programs and help the photographer to quickly receive the right colour temperature in a photo. (Harris, 2017)

Simultaneous contrast
A last visual perception that is important to understand is simultaneous contrast and assimilation. It describes how surrounding colours influence how the brain perceives the colour of an object.
Simultaneous contrast is useful to understand when photographing a product. It describes that one colour on different backgrounds appear differently. In the example of Figure 44 the grey on black looks lighter than the same grey on white. Lighter backgrounds let an object appear darker and a darker background will let the object appear lighter. Simultaneous contrast also appears with chromatic backgrounds. Figure 45 shows grey boxes with a coloured background around it. The grey box with a yellow background seems to be blueish and vice versa and the grey box with red background appear greenish. The object that is surrounded by a colour will get a filter of the complementary colour of the background colour.
The opposite contrast of the simultaneous contrast is assimilation. Assimilation describes the decreasing effect of the simultaneous contrast. It is however challenging to create this illusion because it does not appear naturally. (Best, 2017)

Figure 44, Simultaneous contrast (Good stuff, w.d.)

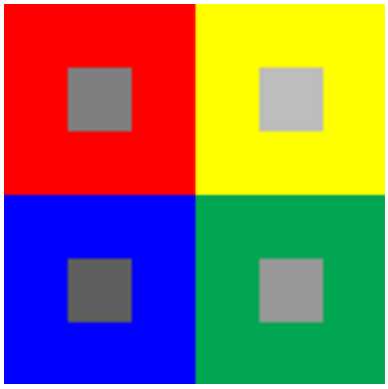


Figure 45, Simultaneous contrast (Stlarson2017)

Study about colour and light
To get a better understanding of how light affects the way we perceive colour, the following study is done. In the set-up, a product is photographed with two types of light: a normal white light and a coloured light. The coloured light is used to make pictures with the complementary colour of the product colour. In this way, it is possible to find out whether the picture should be made with its complementary light colour, a normal light, or a normal light and a complementary coloured background.

In the first experiment, different photos were made with different conditions, see Figure 46. During the experiment, the camera was set to one setting and no editing of the pictures was done. The colour of the product is taken from each picture and placed on the right. It shows that the different conditions give a big difference in the way the colour is shown in the photo.

From the experiment, it can be concluded that light has a big influence on how we perceive the colour of a product. There is no clear conclusion on what combination of colour light or background gives a good impression of the product colour. However, this shows that translating real colour into digital perception is a difficult task. Calibration of the correct colours can be done by a colour passport or computer adjustments. Figure 48 shows the difference in how the camera perceives the colours. The first picture shows the purple product on a complementary yellow background with white light. In the second picture, white light is replaced by purple light. Looking at the yellow background in real life, it becomes fluorescent. The second picture shows this partially. The last picture is made with the same conditions as the second picture, only zoomed in on the product. The yellow colour disappeared and the product becomes blueish. It shows how much the entire environment influences the captured colour.

In the last experiment, the colours of the colour wheel in a product were photographed with all the light colours of the colour wheel. (Figure 47) The first picture is made with white light. In this way, the colour change in different light conditions becomes visible.

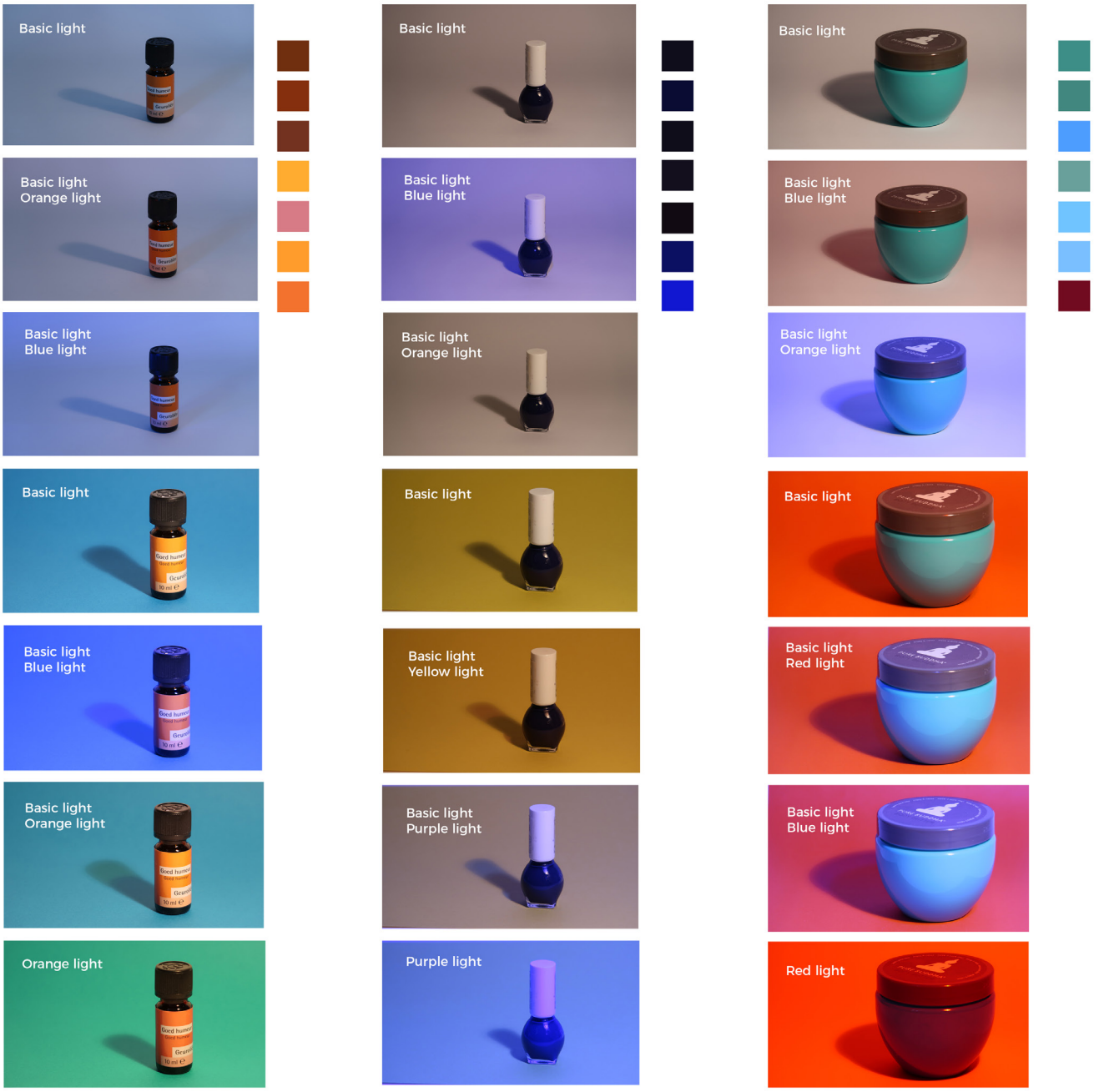


Figure 46, Colour study 1: Using complementary colours in background and lighting.

Figure 47, Colour study 2: Behaviour of colour light on colour surfaces.

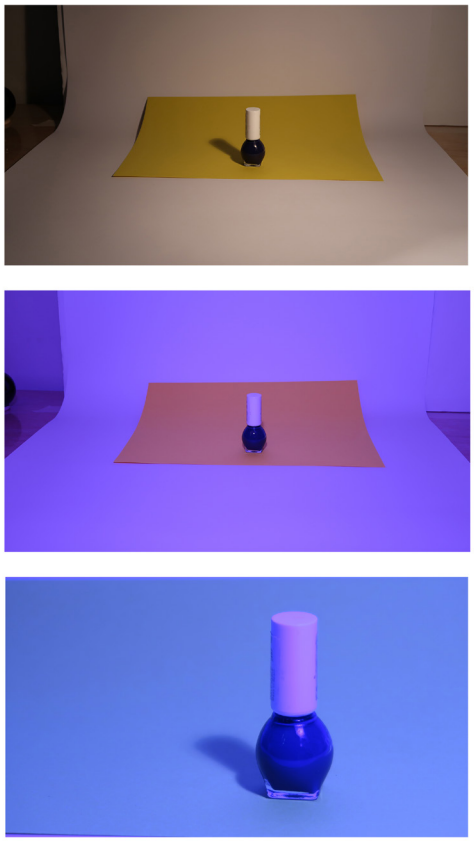


Figure 48, Different colour perception. The studio in normal light is shown in the first image. The second image shows the same setting with a complementory coloured light. The yellow background becomes fluorescent. By zooming in this effect disappears.

Summary

Light interaction with a subject makes it possible to photograph. Light shows the shape, material and colour in a specific way. Knowledge on how to work with light is necessary to apply in the concept.
Light has different interactions with materials. It can be reflected, absorbed or transmitted. Reflected light is bounced off a surface. This can happen via direct, diffuse or polarized reflection. Material properties determine what kind of reflection will occur. For example, a matte material scatters the light diffusely.
Absorption happens when a surface absorbs light while creating heat. For example, a black surface will absorb the light. With transmission, the light is transmitted through a surface, e.g. glass.

Directions and types of lamps help to create the desired reflection and shadows to communicate the material properties, shape and colour of the subject.
In photography, there are six types of light: normal light, soft box, grid, spot, light bar and ring flash. All give different illumination on the subject and different shadows.
In general, two lights are used to enlighten a scene. The key light is the main light and determines the direction of the cast shadow. The fill light will light up the darker places on the subject. A third backlight can be added for highlighting contours.
For communication of the colour, it is better to use diffuse light (light from all directions) to decrease the contrast on the subject.

Colour perception is also one of the biggest issues in photography. The use of different coloured backgrounds and lightings can influence how the colour is perceived by the observer. Using complementary colour contrasts will increase the intensity of the subject's colour. For every scene, the photographer needs to be aware of the colour perception and how to deal with it.

6. PHOTO EDITING

Many photographers use Photoshop as an editing software to edit their photos. This is one of the possible softwares. Adobe Lightroom is another example and some camera companies like Canon provide software together with the camera. This chapter is focused on Photoshop because this is most applicable for IDE students. Photoshop has a wide range of possibilities to adjust a photo and therefore it is important to understand these possibilities.

Camera raw filter is an important plug-in of Photoshop to edit photos. This filter makes it possible to change the white balance, colour, and luminance. Besides the camera raw filter, the retouching pencil is used a lot. This tool makes it is possible to remove dust or other imperfections. Next, the use of these two will be explained. This is one example of all the possibilities.

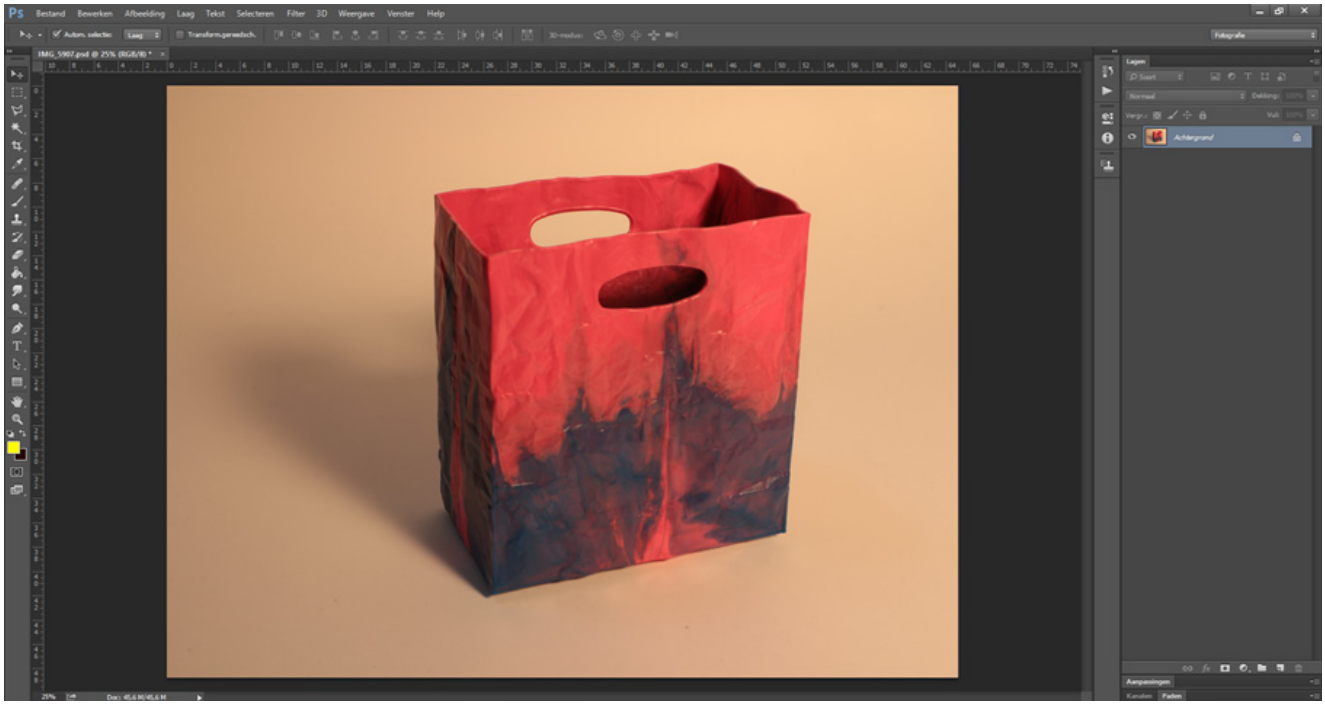
It is not always possible to place all the preferred reflections and shadows in a photo. Lenden (2019) explained in the interview that he merged two pictures in Photoshop, one with the right reflection and one with the right shadow. This relatively simple task can be executed by placing the two photos in front of each other and using the eraser to bring some parts to the front.
He also explained that dust is one of the main time-consuming problems. It is better to prevent dust as much as possible by using high air pressure or a dust fiber cloth.

When editing photos, it is important that this is done in a regular light environment. An environment that is too dark or light influences the way the colour of the screen is perceived.

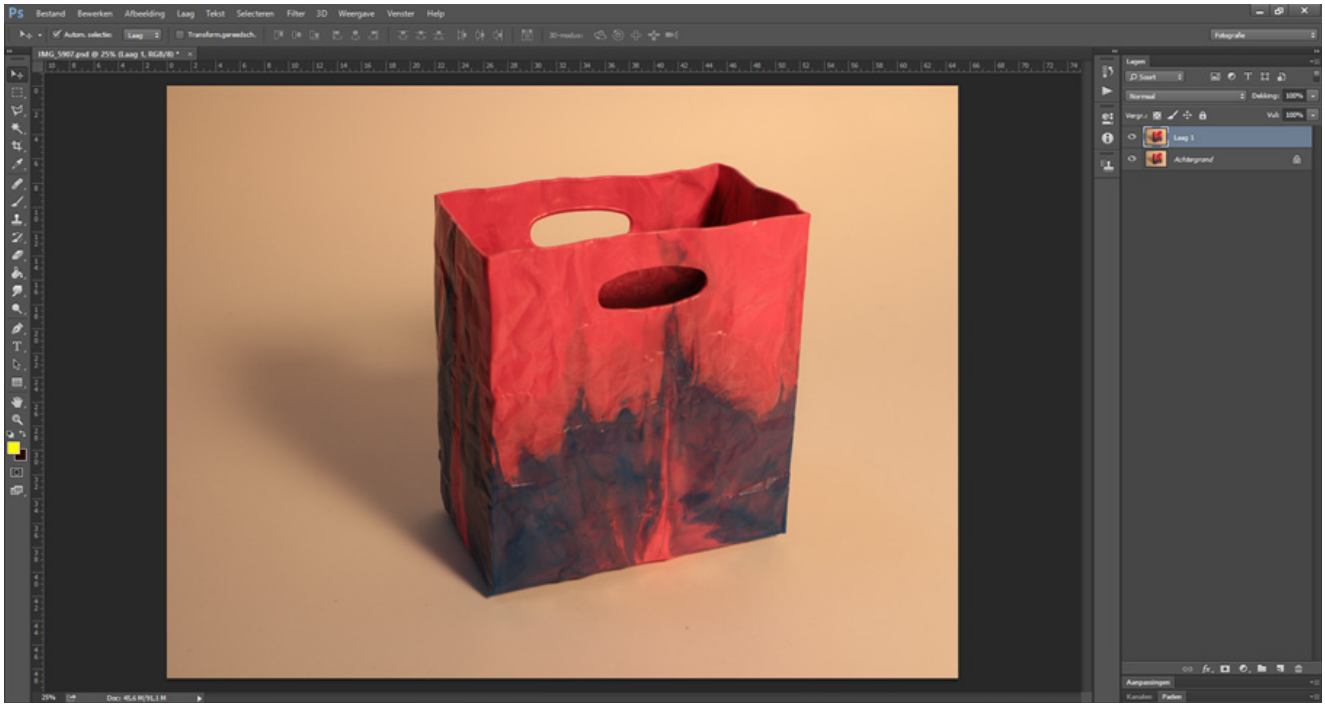
6.1 Steps through photo editing in Photoshop

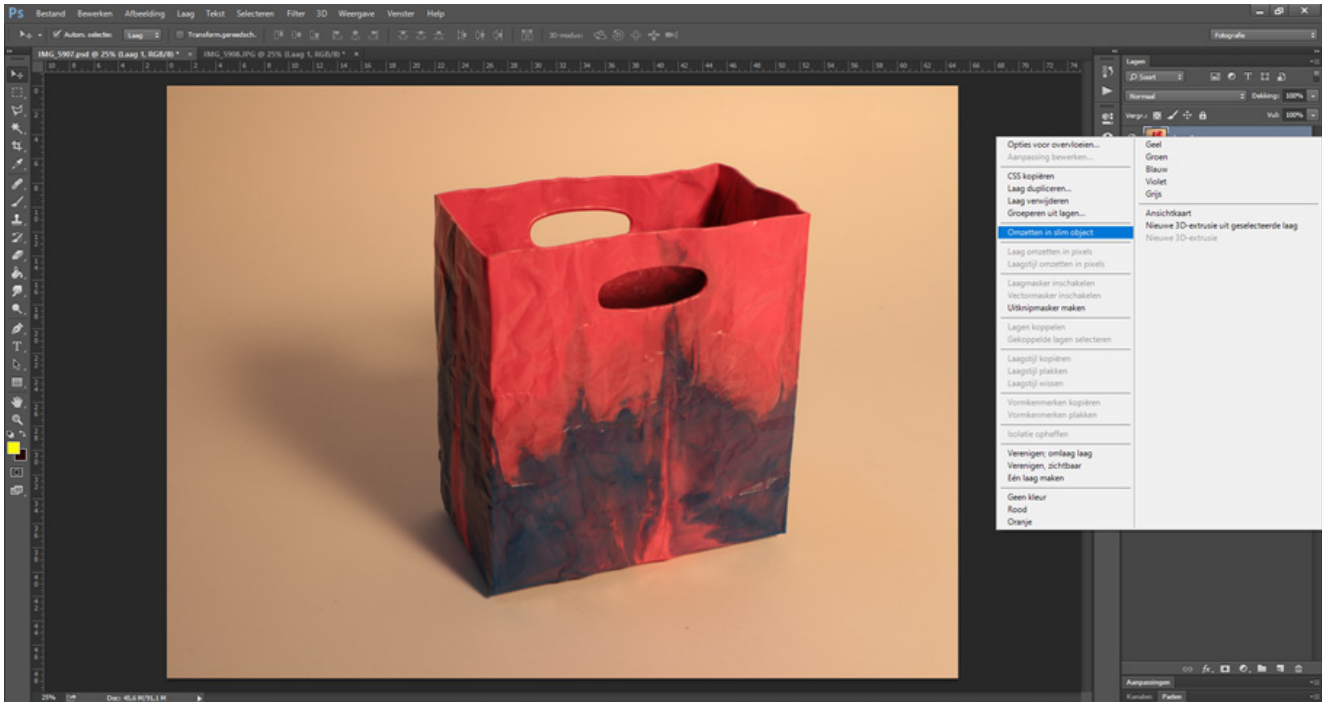
6.1.1 Preparation of image for camera RAW

1. Open an image in photoshop

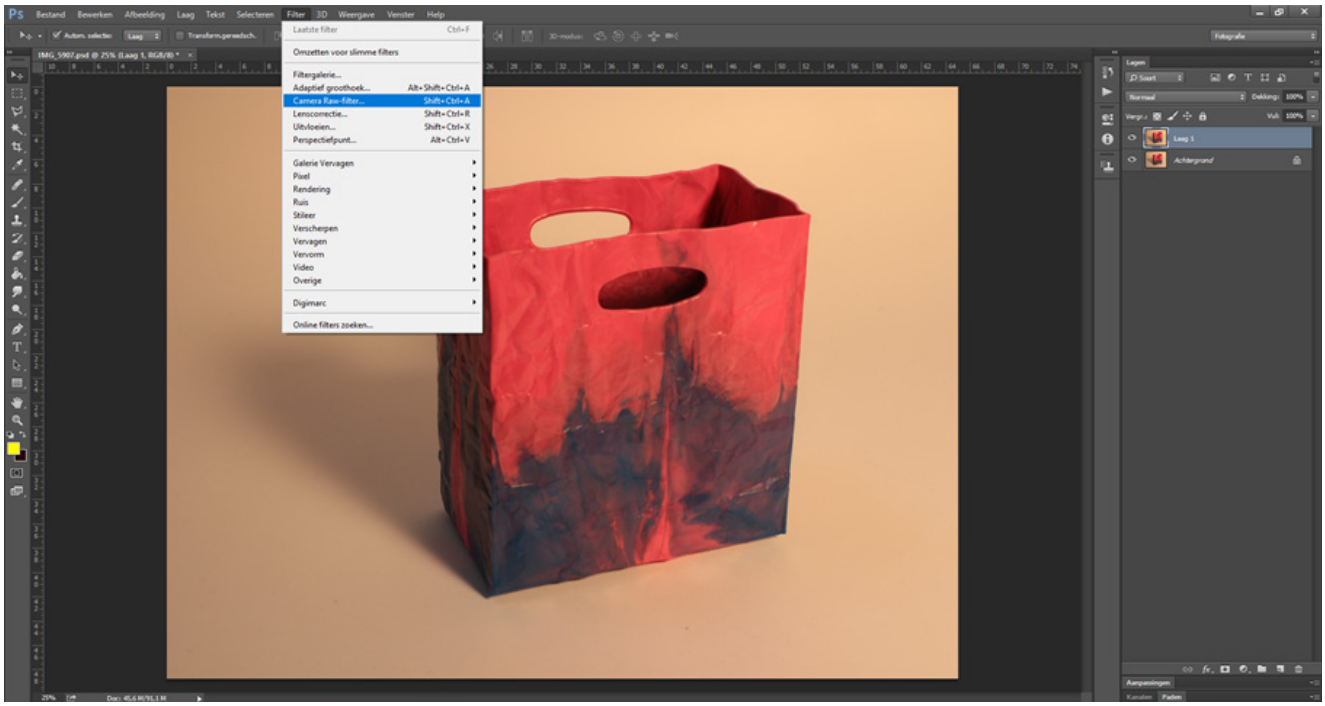


2. Make a copy of the background layer and make a smart object of this layer. Right mouse-click on the layer you want to change > smart object.

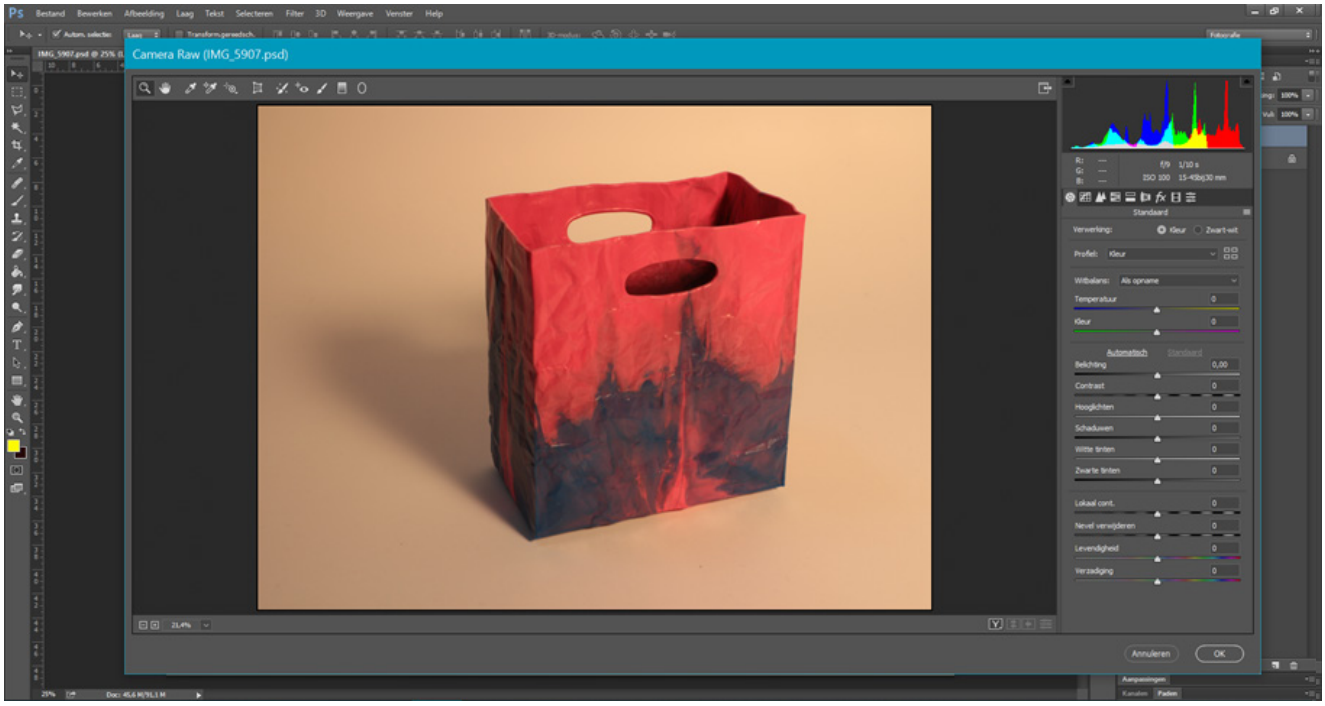




3. Open camera raw-filter. This option can be found in filter > camera raw

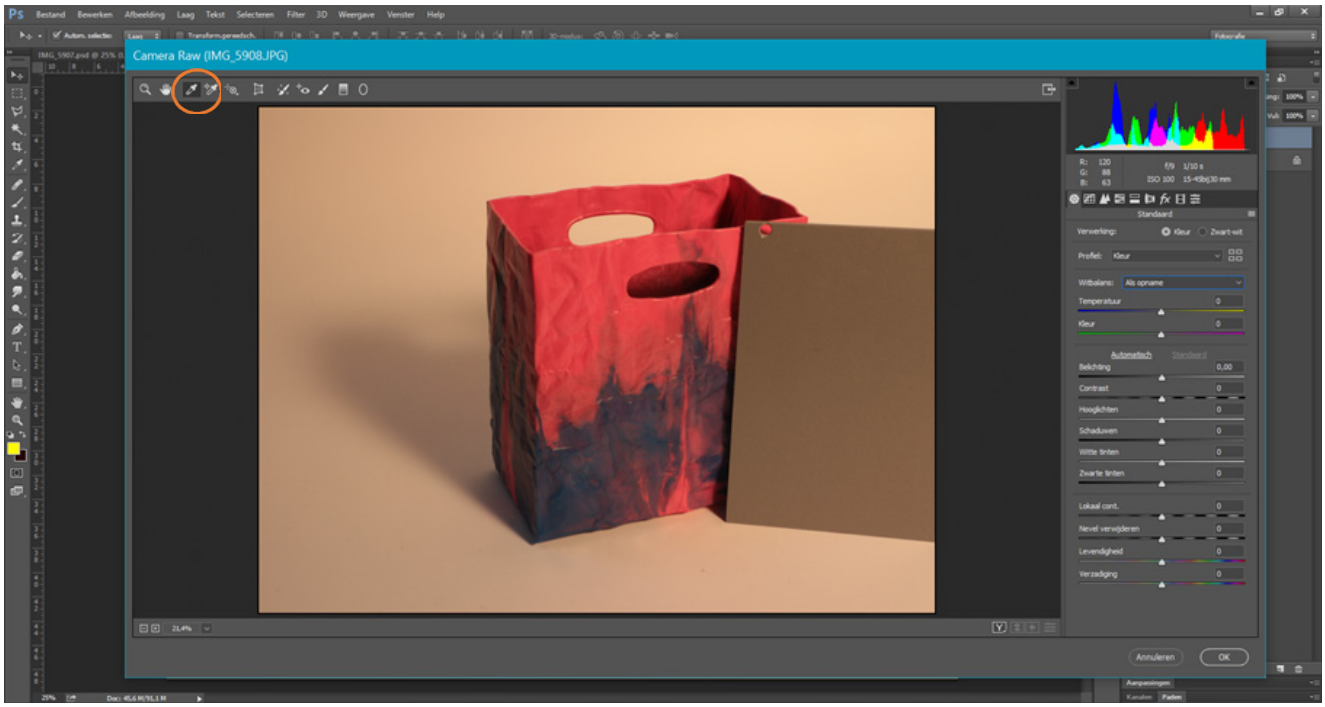


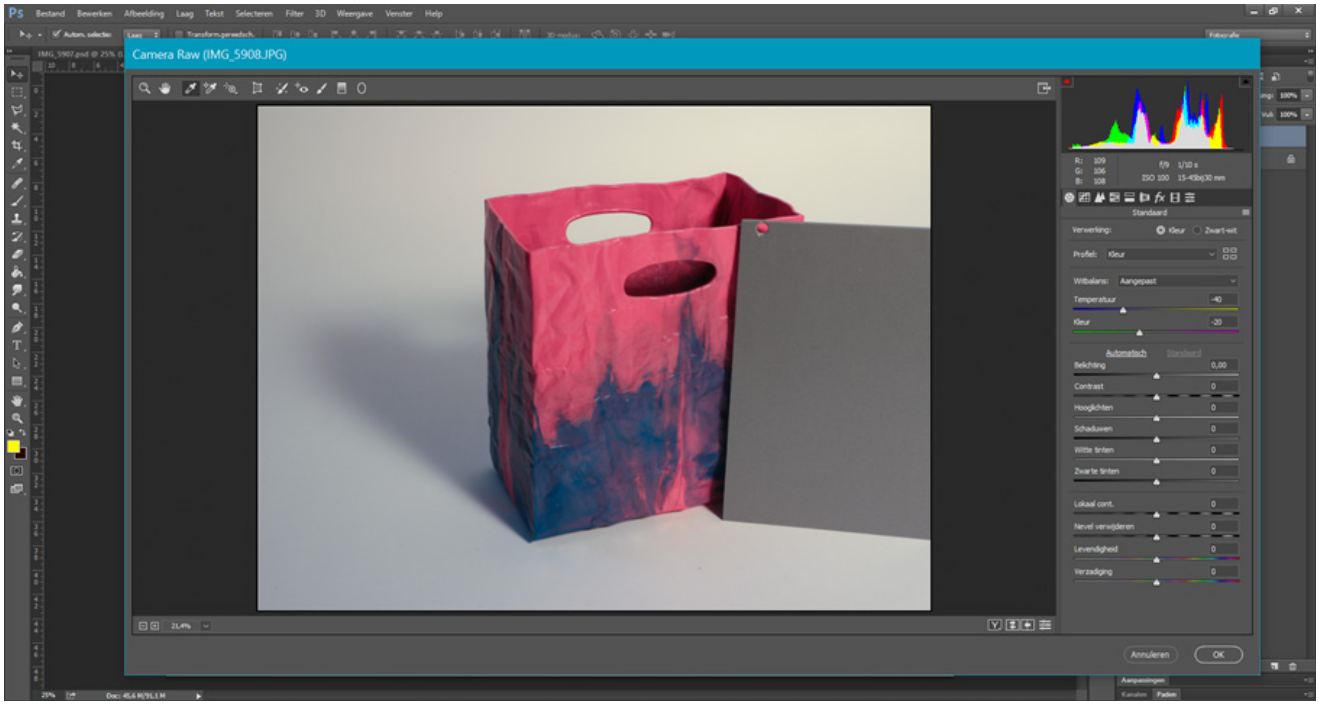
4. A new window with the options of the camera raw-filter opens. Here, the temperature, colour, light, contrast, shadow and black and white tints can be changed.



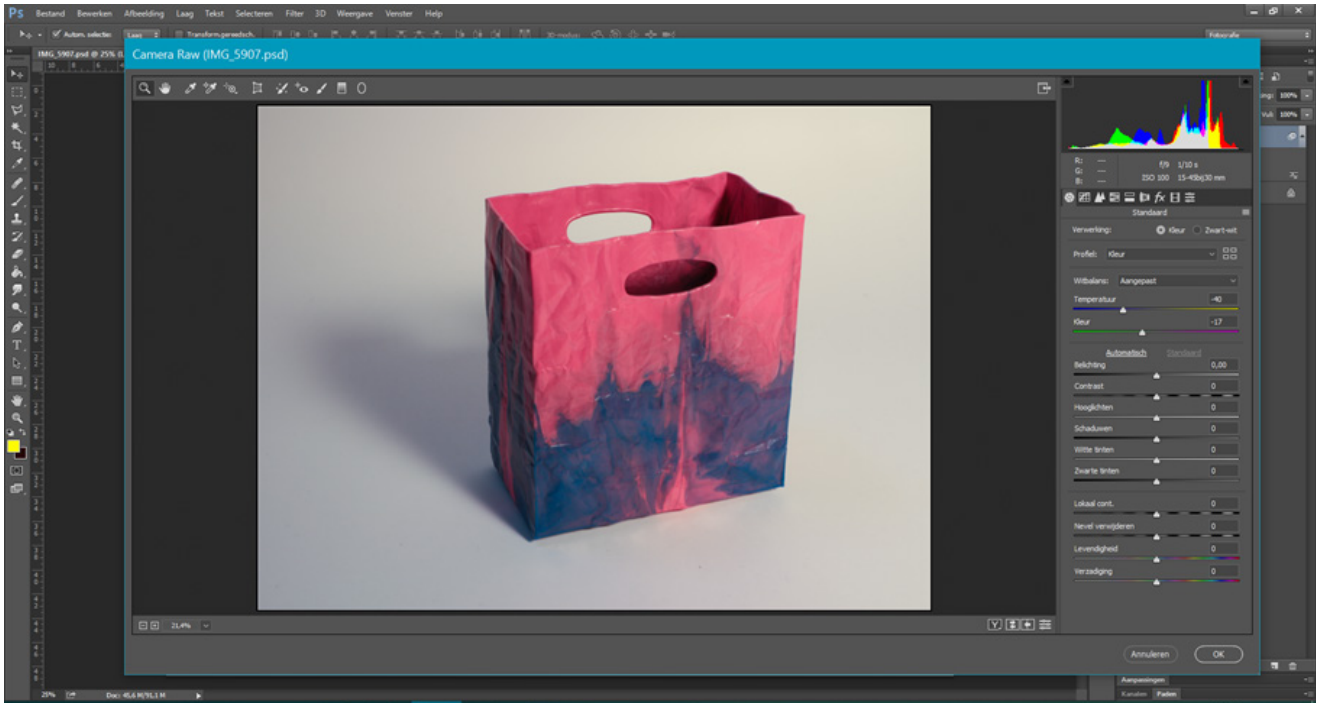
6.1.2 Colour balance with grey-card

5. When using a grey-card, open the photo with the grey-card in a new window of photoshop and open the camera-raw filter for this picture.
Use the eyedropper for the white balance. When clicking on the grey-card, Photoshop will automatically calculate the temperature and colour.

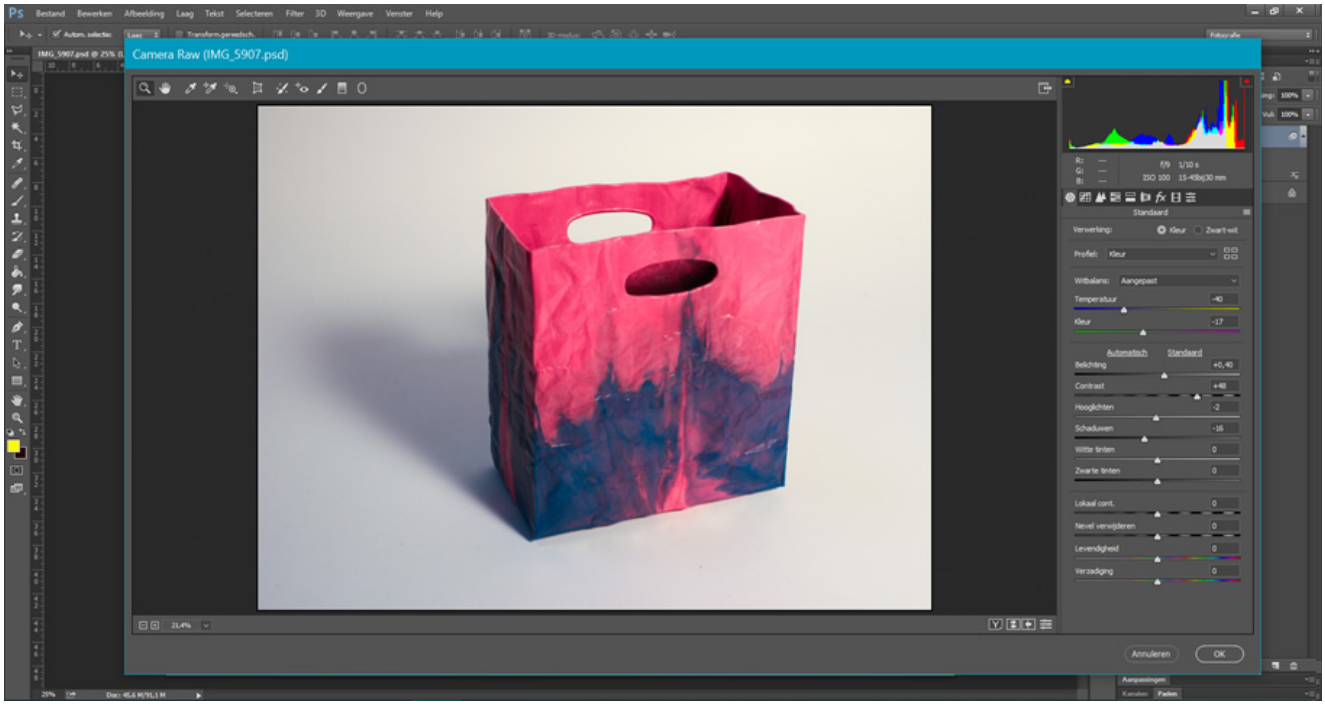




6. Remember the value of the temperature and colour and place these values in the camera raw-filter of your photo.

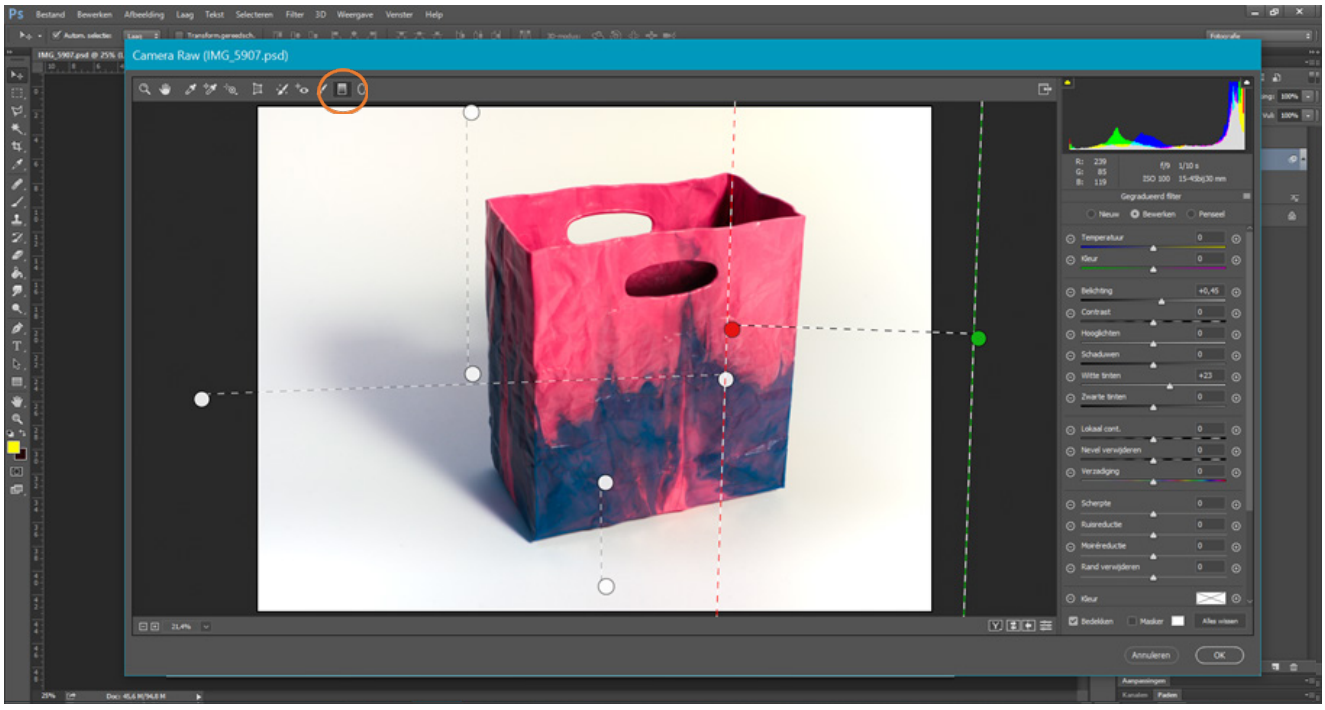


7. From this point it is possible to change the lighting, contrast, highlights, shadows, white and black tints as preferred.



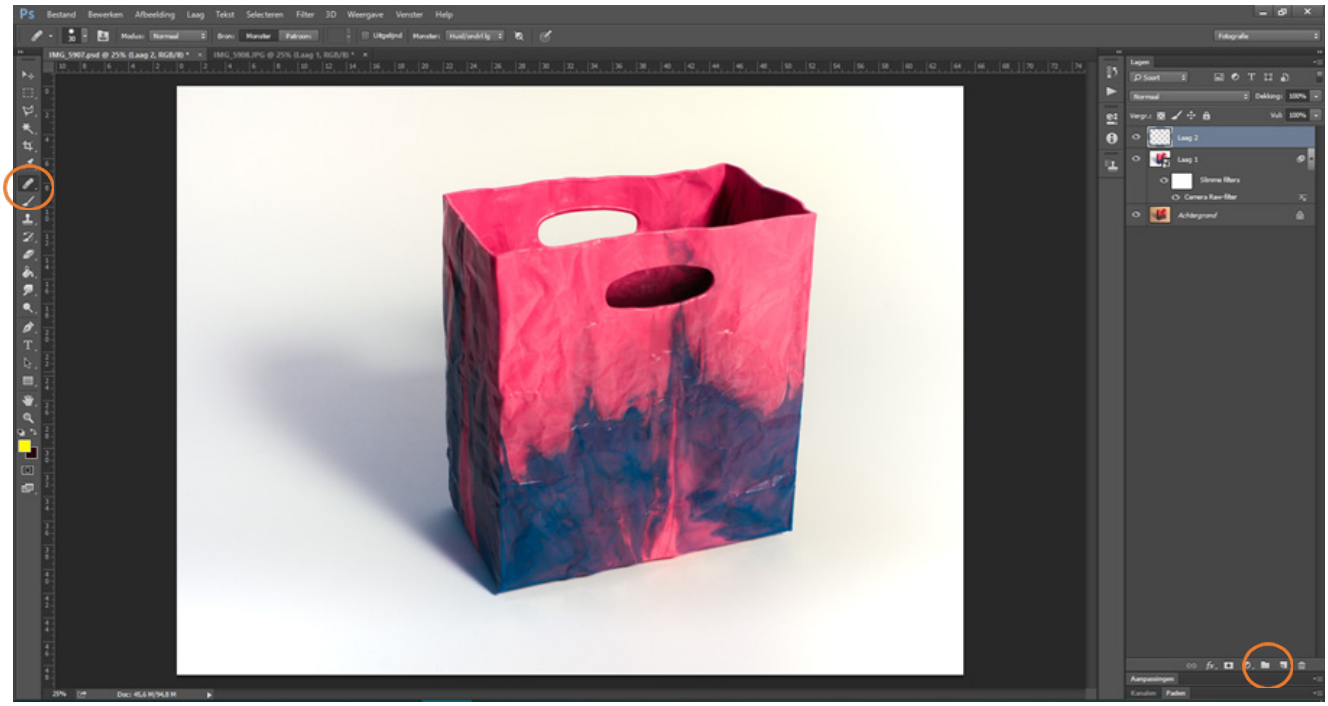
6.1.3 Graduated filter

8. With the graduated filter it is possible to make some areas whiter with some transition.

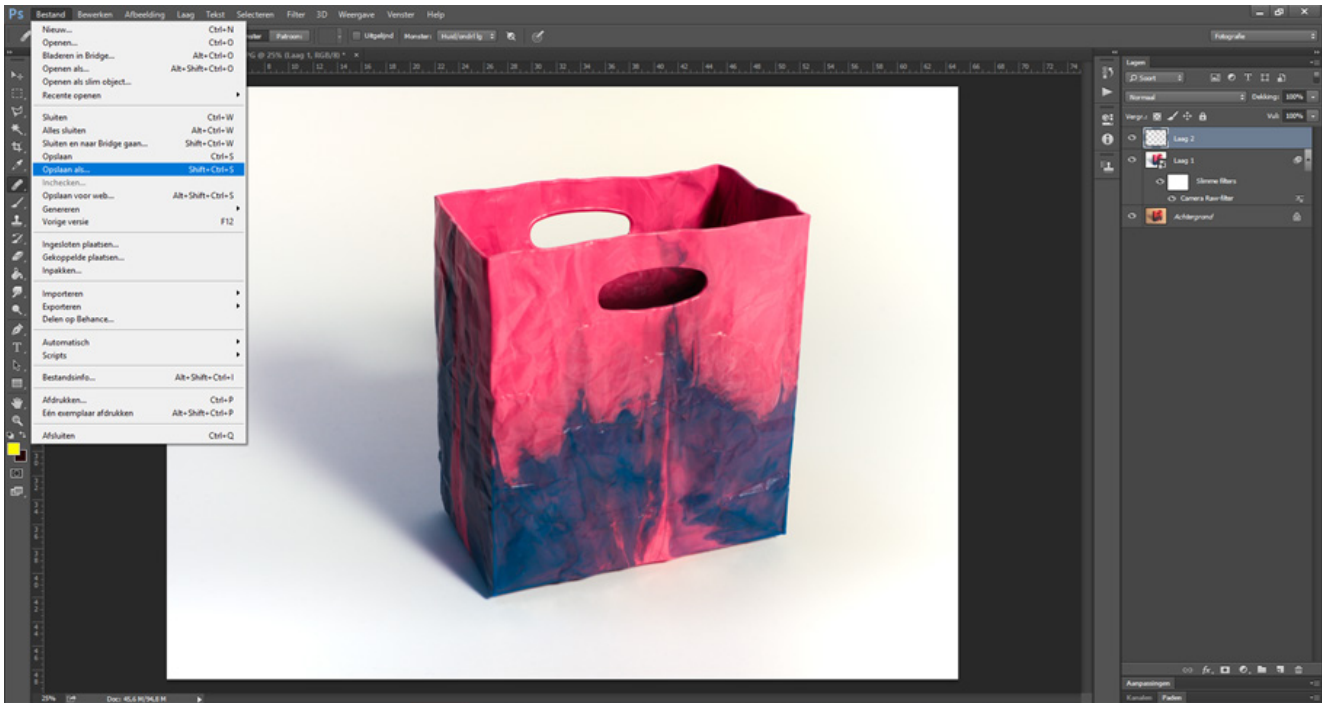


6.1.4 Retouch tool

9. To finalise the photo, close the camera raw-filter by clicking on OK, add a new layer and click on the retouch pencil. With this tool it is possible to erase dust or non-preferred highlights. Use alt + clicking on the area just beside the replace area, and then go over the replace area. The selected area with alt + click will replace the area which is not preferred.



10. Save the image.



CONCEPTUALISATION

In this part of the report, the process of finding a solution to the problem found in the research part and the development of the idea will be discussed.
The process started with ideation through brainstorming (Rozenburg & Eekels, 1998) and converging of the ideas to one final concept: the light studio. This concept is further developed in the separated parts, the hardware, software, and interface. The hardware is the physical shape of the concept, the software is the communication of the separated elements by Arduino and Processing and the interface which is visible for the user and interacts with the hardware.

7. IDEATION

The concept phase started with looking back to chapter 2 and its interaction qualities. The interaction qualities were:

- Confident
- Motivated
- Joyful

With these elements questions were made like: “How can you let someone feel confident?” or “How can you motivate someone?”. Answers to these questions are the ideas towards a concept. The brainstorm board is shown in Figure 49. Green are the questions, pink sub-answers and orange product ideas.

As a next step, these ideas are combined to concept ideas. These are more defined ideas towards a product. Eight different concept ideas (Figure 50) were created and rated on six qualities (motivation, joyful, confidence, understanding, cooperation, quick process). Concept idea 1, 2 and 7 had the highest scores (Table 1). The concept is build up from the best elements of the concept ideas.

The concept is mostly based on idea 1. From the computer, it is possible to adjust the light in the light studio and make the picture. It works as follows: A camera is standing in front of the light studio. The camera is connected with the computer and can be operated by that computer. In the light studio, the lights are fixed to certain corners. The computer can change the lights through sliders. In this way,

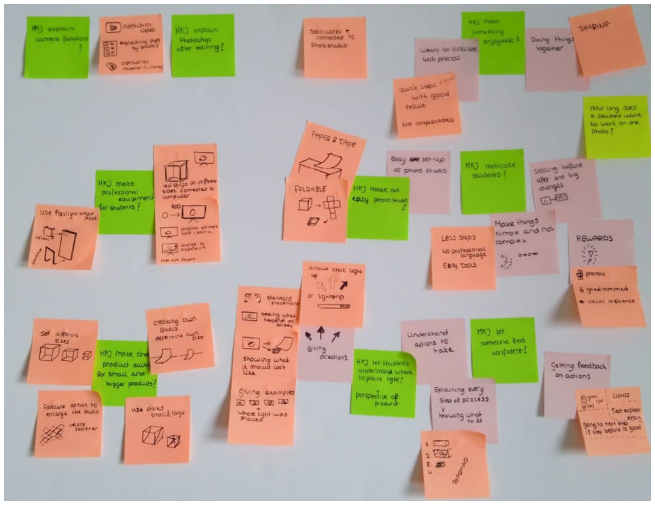


Figure 49, Brainstorm board with first concept ideas.

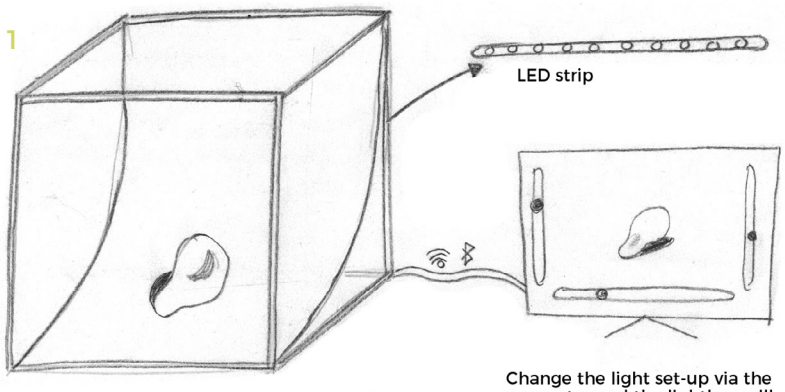
the student can directly see the light changing on its computer screen. It also gives direct feedback on how the photo will be. It is often difficult to see in 3D how the image will look like in 2D, especially on a small camera screen.

This idea is complemented with two elements of idea 2 and 7. Students need an explanation about photography and lighting in order to capture a good image. Therefore, the interface on the computer will ask some questions which will finally give feedback on what to do. Also, information about camera setting and after editing will be integrated. Altogether this will let students understand photography and feel comfortable about making professional photos.

	Motivation	Joyful	Confidence	Understanding	Cooperation	Quick proces	
Idea 1							4,5
Idea 2							5
Idea 3							3
Idea 4							3,5
Idea 5							3
Idea 6							2,5
Idea 7							5
Idea 8							4

Table 1, Interaction qualities on top and the decree in which this is in the concept idea. The three ideas with the highest score on the interaction quality are used to combine into one final concept idea.

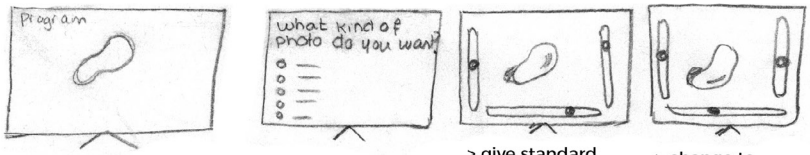
Idea 1



Change the light set-up via the computer and the lightbox will change.

Idea 2

Add 3D model

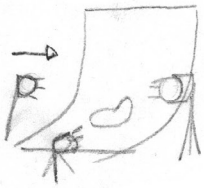


> work with layers
> give the product a material layer

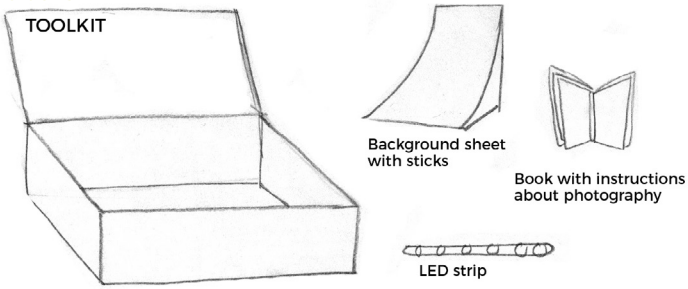
> give standard option

> change to preference

Apply to photostudio

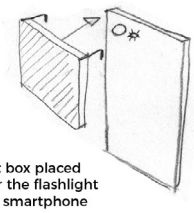


Idea 3



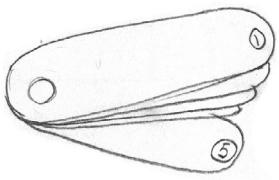
Idea 4

Different small tools to make the first step easier.



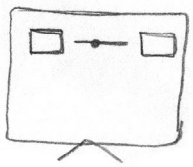
Soft box placed over the flashlight of a smartphone

Idea 5

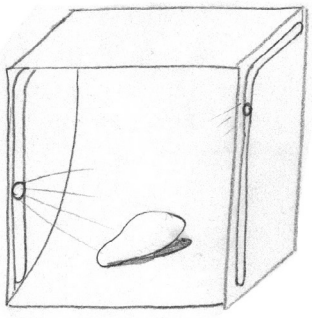


Show all the steps with examples

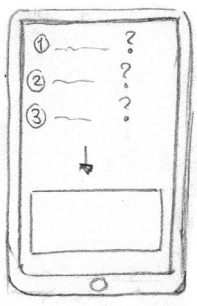
Idea 6



Make two standard pictures with the light on a certain position. Then find the preferred position with a slider.



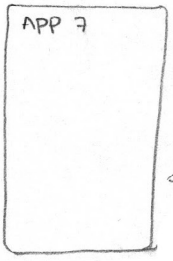
Idea 7



An app which gives example pictures and tips for setting up the studio.

Questions that will be asked:
1. What setting/ambiance do you want to create?
2. What material is your product?
3. Do you make a picture inside or outside?
4. What is the shape of your product?

Idea 8



The app of idea 7 combined with standard tools for setting up the studio.

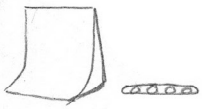


Figure 50, Eight concept ideas which were created from the brainstorm board.

8. CONCEPT DEVELOPMENT

The concept has different parts which need to be developed which are the light studio, the interface on the computer and the connection between the camera, computer and light studio.
Therefore, this chapter is separated into three parts: light studio, interface, and programming.

8.1 Light studio

The main body of the light studio consists of an outer shape in which the lights are integrated. It needs a specific type of light which can be used for good photography. Besides, the studio needs a camera and background. All these elements will be highlighted. Each topic has a separated part in which the prototype for the user test in Chapter 9 will be discussed and what the difference will be from the real product.

8.1.1 Shape

On the market, light studios are often made in a cube shape. Figure 51 shows five different types of mini light studios. In the first two examples, a photographer needs to add lights. These lights can be placed on the sides, on top or underneath. The studio sides create a soft light on the product. Placing a light in front will give a hard light. The last three examples have an integrated light. The light is movable in example 3 and in example 4 and 5 the light is fixed. For the concept, it is interesting to look at the studios in which the light is fixed. In example 4 and 5, the light is coming from the top. The light is reflected by the sides and gives an equal diffuse light on the product. This set-up is meant for product photography for webshops. A hole is made on top of these studios to make it possible to photograph from above. It is interesting to integrate this into the concept.

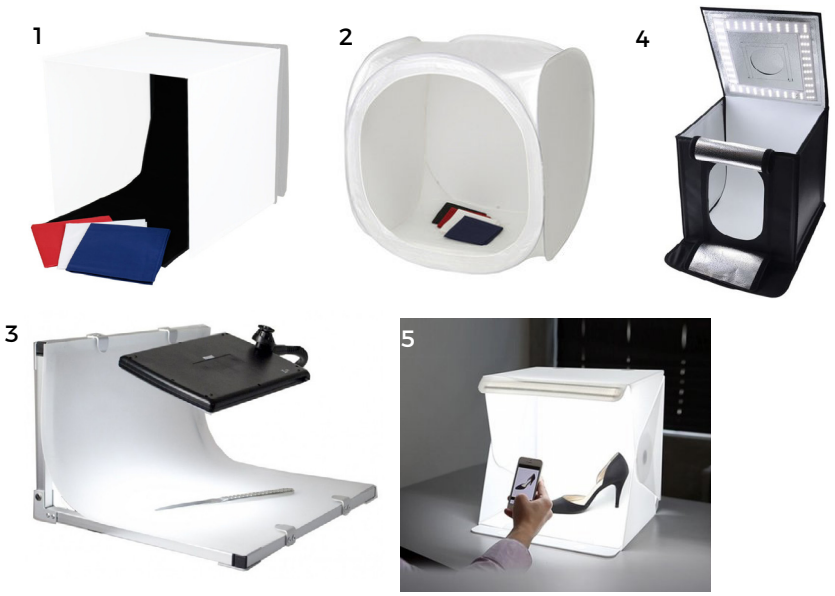


Figure 51, Five different light studios with en without integrated light.
1. (CameraNu.nl, w.d.) - 2 (Folux, w.d.) - 3 (FotoKonijnberg, w.d.) - 4 (KameraExpress, w.d.) - 5 (Bol.com, w.d.)

	Kabelkoning	ABC LED
Light temperature	5000 Kelvin	6000-6500 Kelvin
Light intensity (per LED)	9,7 lumen	22-24 lumen
CRI	80 %	> 95 %
Dimmable	Yes	Yes
Price	€52,50	€39,95

Table 2, Comparison of two different LED strips. (Kabelshop.nl, w.d.) & (ABD LED, w.d.)

Light movement is important in the concept. It needs to give the student an idea about light and the effect on the photo. The light should be able to rotate around the subject in order to create an image which communicates the shape of the product in a correct way.
The light will be limited in its movement when the LED strip is only placed on the corners of a cube studio. A rounded sphere shape would be perfect to use as studio shape. This gives the light freedom of moving in all directions around the product. An example is the light studio of Paul Develic (Figure 52).

The light studio of Paul Develic is used as inspiration for the shape of the concept. This will be made of a half sphere and using an icosahedral structure for the placement of the LEDs. By using this structure, the light will be equally divided. The light in the light studio is not coming from underneath. For students it is not necessary to have this option. More importantly is the light coming from the top. The outer part is covered by a black cover which will keep the light out. There is an inner part which can be used by the student if preferred. This cover will work as a softbox and can be used for reflective products.

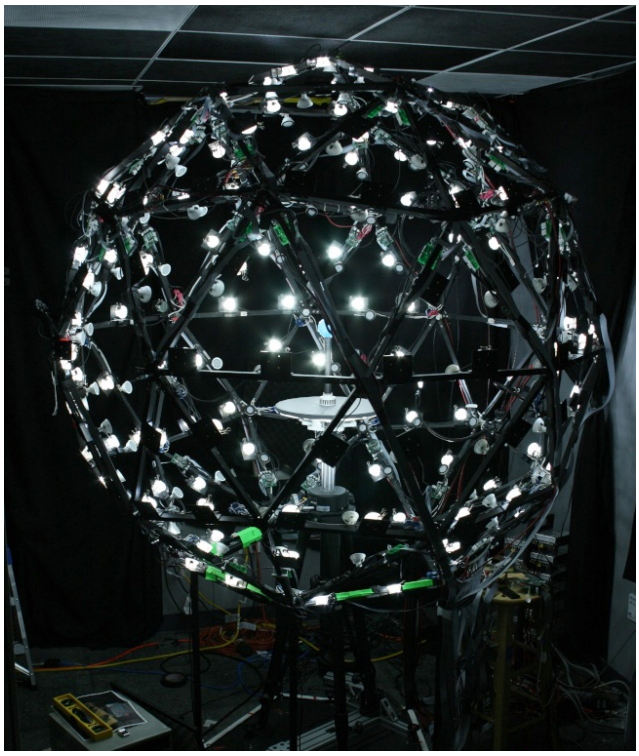


Figure 52, Light studio of Paul Develic. The spherical shape is used for the concept. (Wan-Chun Alex Ma, w.d)

8.1.2 Light

There are different focal points when choosing the right light for a photo studio. These are colour temperature (chapter 5.1.2), Colour Rendering Index (CRI) (chapter 5.2.2) and whether the light is dimmable. LED is a good light source for the product. Thomas Lenden (2019) advised to use this light source, because it gives a good light intensity and it is mostly used in photography. The temperature that is used for making professional photos is 5000-5500 Kelvin which is related to daylight. This colour temperature will also be integrated into the product.
Besides the colour temperature, CRI is an important element. The CRI explains how well a light communicates the colour of a subject. The CRI for LED light is preferably above 85% in product photography. (DIYPhotography, 2015)

After doing research about the LEDs on the market, two different LEDs are shown in Table 2 for comparison. The first one is a LED strip from Kabelkoning (w.d.) and the second LED strip is from ABC LED (w.d.). The LED strip from Kabelkoning has a good light temperature and is dimmable. The CRI is a bit lower than preferred. The ABC LED has a higher light intensity (22-24 lumen) then the Kabelkoning and is also dimmable. Besides, the CRI is higher than 95%. Only the light temperature is higher than 5000-5500 Kelvin. In the light studio, the LED strip of the ABC LED will be used. The colour temperature can be adjusted through after editing. More important is the intensity of the light and the way it communicates the colour.

8.1.3 Studio background

In the interview with Lenden (2019), he advised to use a white PLA 0,3 mm background. This flexible sheet is matte and does not give a structure on the photo which paper will do. By the matte surface, it does not give reflections on the photo. The material is also easy to clean and will not wrinkle.
This background sheet can be bought at Camumet (w.d).

8.1.4 Camera

A system camera will be integrated in the main body of the light studio. It can move along the spine of the construction and this way it keeps the same distance from the subject. Only the viewing angle is changeable. For bigger subjects it is needed to have a wide angled view. Smaller subjects need to be zoomed in. Therefore a zoom lens will be used. This might causes some deformation on the subject. The editing tool in the interface can solve the problem of deformation. The concept needs to explain to the student that they should use the lens with a 35 mm (cropped frame camera) lens distance to receive the view a human eye would have. When they decide to zoom, they can edit the deformation.

There is also the choice between a full frame or cropped camera. The main choice lies on the ratio of price and quality. The light studio needs to capture good quality photos, but compared to the mobile phone cameras which students normally use, the cropped camera will have enough quality for this product. The full frame camera would be too expensive for the way it is used.
When looking to the type of camera that will be used in the light studio, the system camera covers all the needs. There is no need for a DSLR camera. A DSLR camera works as a system camera when it is connected to the computer. The mirror is flipped upwards to receive an image on the screen of the computer. Nothing will be visible on the computer screen when the mirror is down. The system cameras are good developed in the last years and give the same quality of a DSLR camera. Only difference will be the autofocus. In system mode the camera will need more time to get the subject in focus. Students could use is the manual focus as an alternative.

8.2 Programming

Three programs are needed to let the camera, computer, and light communicate with each other. These are Arduino, Processing and Canon camera control software. The sliders, buttons and other features of the interface are made in Processing. This program communicates with Arduino. Arduino is linked to the hardware. When a slider is changed in Processing, Arduino will receive the data and communicates this to the hardware by explaining what it should do, like turning on a light.
The camera control software is integrated into the Processing interface. This software is able to control the camera in the interface and it shows a preview of the image.

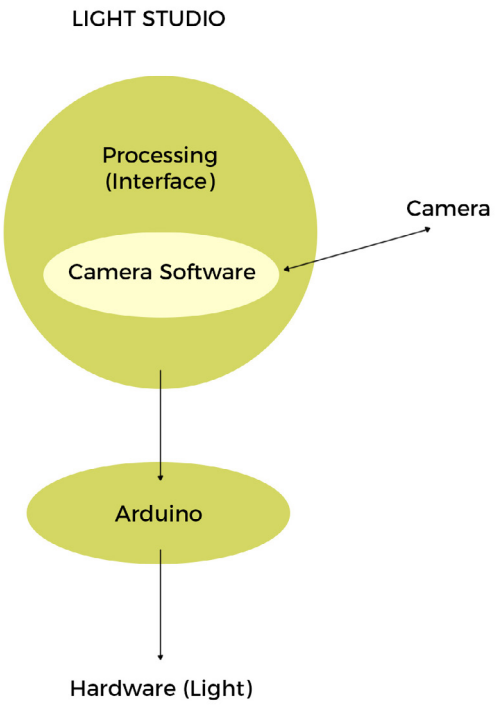


Figure 53, Two programming programs are used, Arduino and Processing, which communicates together. Processing receives data from the interface and communicates this to Arduino. Arduino sends commants to the hardware (LEDs). In the Processing interface the live view of the camera is integrated.

8.3 Interface

The interface is made in different phases. First, some ideation on the lay-out of the different components was done. A final lay-out was chosen and made in the style of the final product.

8.3.1 Ideation

The interface consists of four main parts: the image of the scene, light regulation (light bars and light selection), camera settings and a guide bar.
All separate elements need a position on the computer screen To compare different positions, an ideation is done. The different possible positions are shown in Figure 52. The light bars are based on the three-dimensional space in which the light moves. After the ideation, these bars changed into two bars which will be explained later.

In the first idea, the coherence between the different elements is missing. Related elements are placed too far from each other which makes it hard for students to understand the order of use.
In the second idea, the light bars are placed closer to each other. It might be useful to give the students some feedback on where the light is positioned on a three-dimensional scale in the image. Therefore, the light and its position are shown in the middle of the light bars. The camera settings are placed in the image area. However, it is better to place these above or under the light bars as shown in idea 3 and 4. This gives a better view on the image and more space for the camera settings.
The difference between idea 3 and 4 is the placement of the question bar and the camera settings. In idea 3, the question bar is placed underneath the image of the scene. The camera settings are also placed underneath the light bars. This placement is vice versa in idea 4. Idea 3 has a better reading order. The student will first look at the image, then down to the question bar and lastly go to the right with first the lights and then the camera settings to make the image.
Idea 5 positioned the slider closer to the image of the scene. It emphasizes the connection between the light and the image. The camera settings and the question bar are placed underneath. The only problem with this idea is that the camera settings probably need more space. This is solved in idea 6 with the camera settings on the right and the question bar underneath.
Idea 7 investigated a bit more with a question and advise bar, but this made the interface a bit overwhelming with too much information which distracts from the core intention.

8.3.2 Final layout

The layout of idea 6 is used for further development. Elements of the Canon control system and Photoshop editing were used to create the general settings. The three-dimensional light bars were simplified into two bars: a vertical bar which can regulate the height and a round bar which regulate the rotational movement in the horizontal direction over the sphere, see Figure 53.
The light bars are placed in another screen tab on the right because the shape of the light bars changed. In this way, the student can look at the image and choose the options on the right. These options are separated in light, camera settings, image editing, and information. The last option gives general information about photographing.

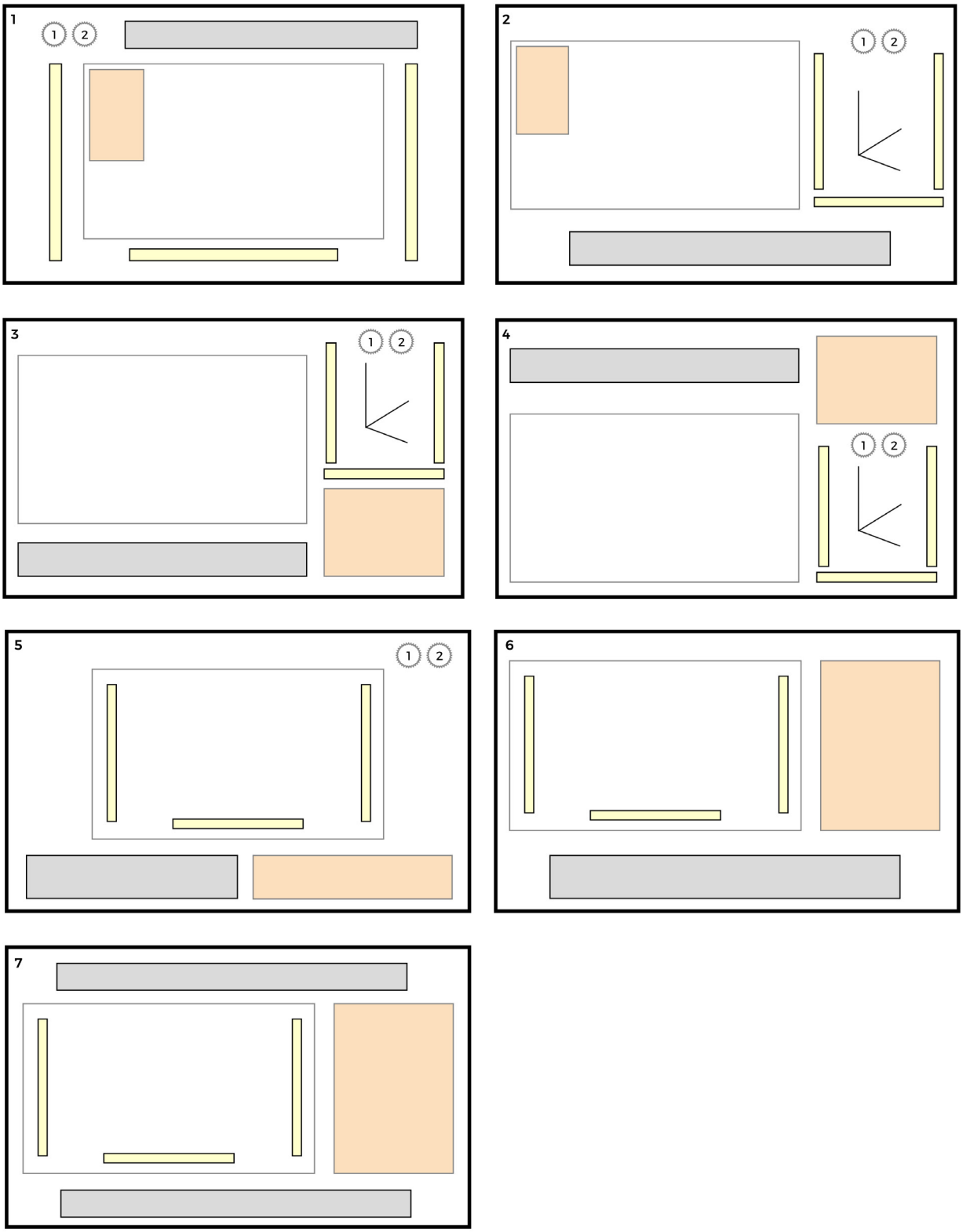


Figure 52, Ideation step towards final layout of the interface. Idea 6 is used for further development.

8.3.4 Interface flow

The light studio has a specific flow through the interface which helps students to understand light in photography and using the camera. Besides, photo editing is integrated to directly edit the image. This paragraph will explain the different elements in the interface and show the interaction flow with the questions and information that will be shown.

First, the student sees the subject through the camera and the light bars on the right side to change the light placement.
The student will be asked below about the subject properties to give information about correctly placing the light. With the answers, the light studio can shift the lights automatically in an estimated direction to give the student guidelines in placing the lights. Next, the student can adjust the lights by sliding the bars and find the preferred position. After that, they can go to the camera settings and photo editing.
Differently from normal photography, the three option (light settings, camera settings, and photo editing) work parallel. The life image is visible in all the three tabs and unlike normal use, it is possible to directly edit the image with e.g. the white balance. The program will add a layer on top of the life image. When going back to the light settings it will keep the editing settings. When everything is well set, the image can be captured. In appendix E, the complete interface can be found.

Light setup

On top, the student can set the key- and fill light, and diffuse light from all directions. The preferred light becomes active by clicking on it. The sliders will change the position of the selected light. It is possible to activate more LEDs by expanding the dot and create a longer light which can be preferred for creating a longer reflection.
The last slider below can regulate the light intensity. The key light will have a high intensity to give the cast shadow. The fill light will have a lower intensity to only lit up the darker places on the subject and highlight contour.

Editing

The editing tab consists of seven options to change the colour temperature, exposure, contrast, highlights and shadows, and white and black tints (Figure 55). The student can receive information about these different settings by sliding over the bar and see the information popping up in the guide bar.

Guide tab

The guide tab is always visible on the bottom of the screen and asks questions or gives information to the student. Especially in the beginning, the guide tab will ask questions about the product shape, material, and colour. Later it will give advises and information about the different settings.

Camera setup

The camera setting, shown in Figure 54, is closely related to the camera control software. It has the same functions to set the right aperture, ISO and shutter speed, autofocus and metering mode (see chapter 4.1 for more information about these modes).
The student can change the settings and directly receive visual feedback in the life image on the left. By changing e.g. the ISO to a higher level, the image will become brighter.

Information tab

Besides the short information the guide tab will give, students can find more in-depth information about the different topics in the information tab (Figure 56). Here, light categories and placement, the canonical materials and shapes, and colour will be explained and how to work with them in photography. Also, information about light and camera settings will be given.

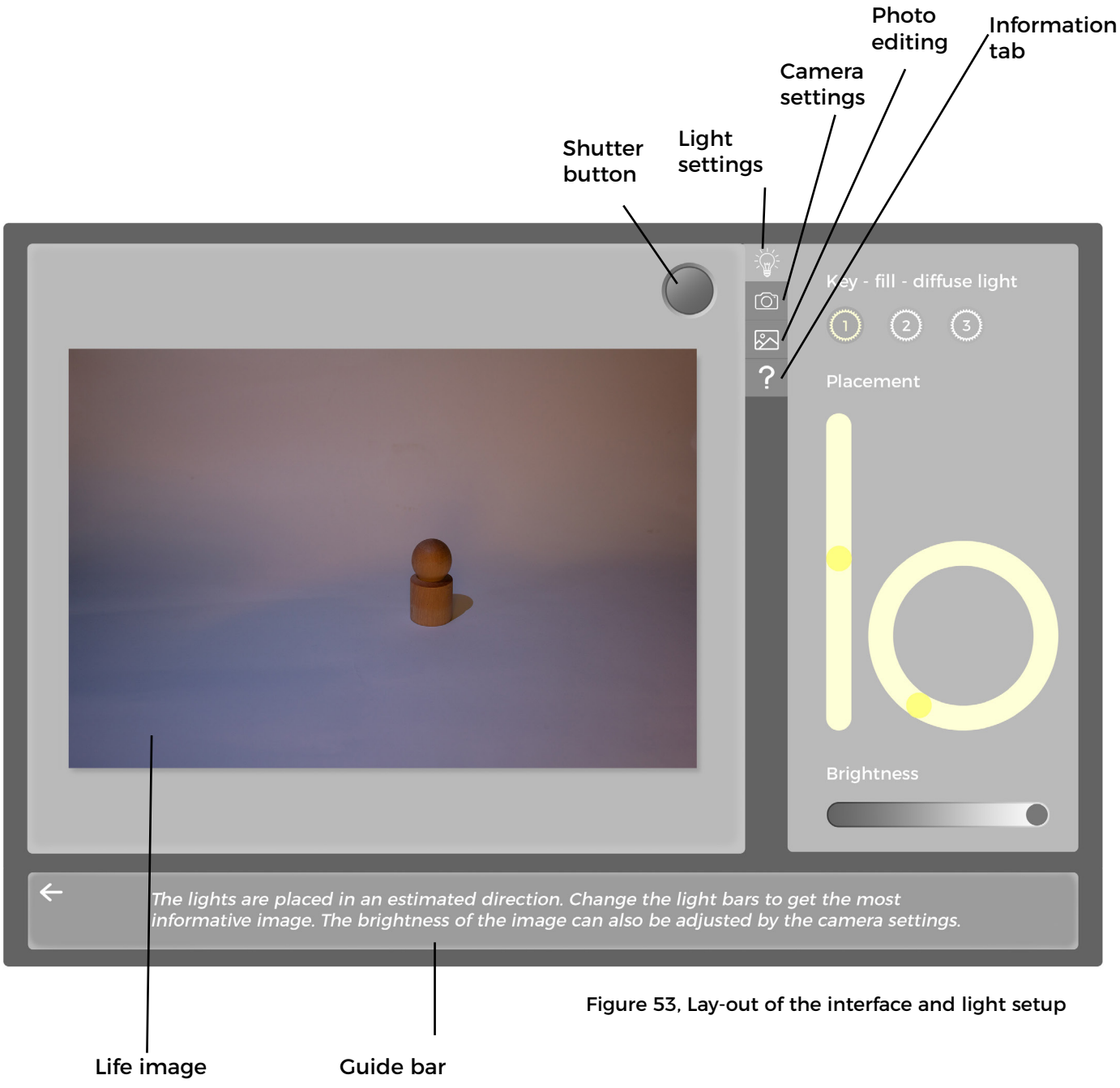


Figure 53, Lay-out of the interface and light setup

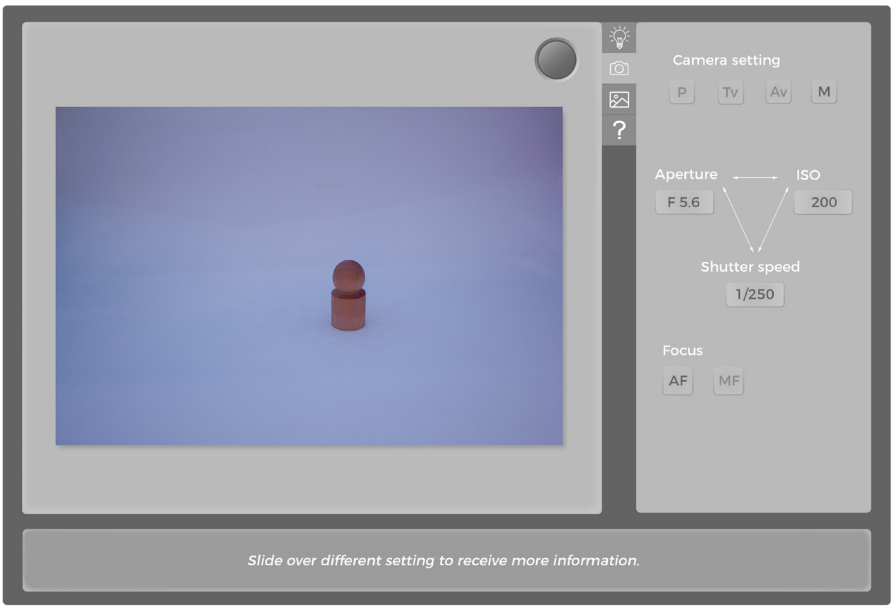


Figure 54, Camera settings

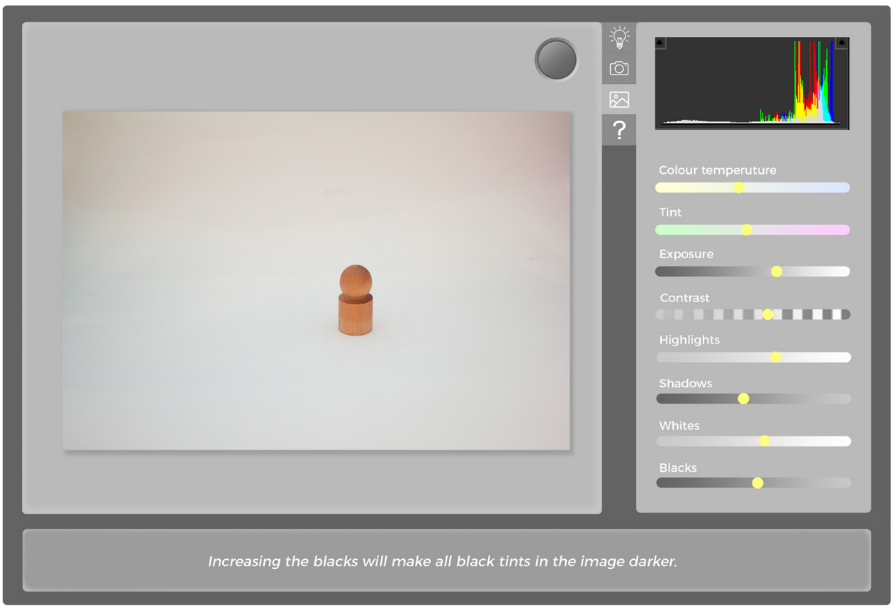


Figure 55, Photo editing

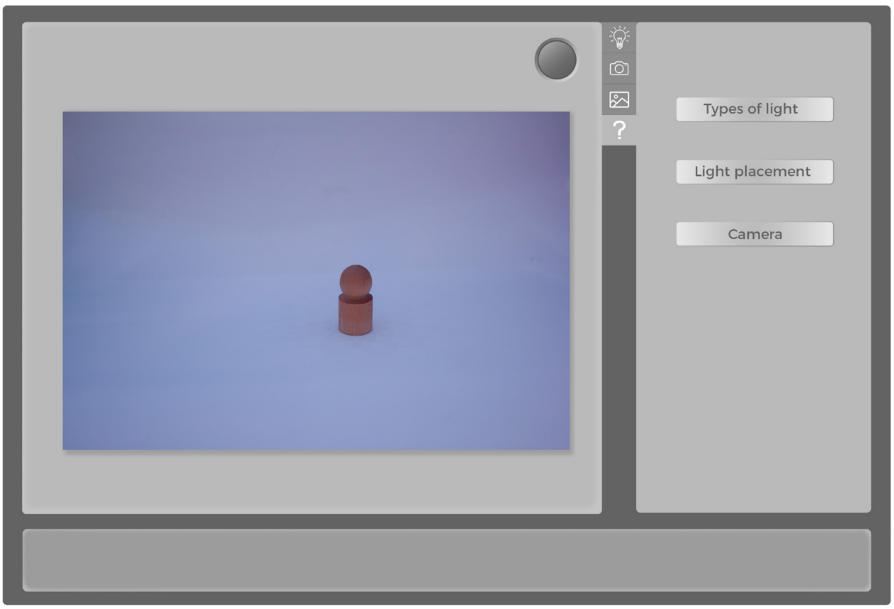


Figure 56, First information tab

8.4 Buidling the prototype

In order to test the product with the students from IDE, the prototype is built. Some changes were made to achieve the same interaction with the limited possibilities. The differences from the real concept and the prototype considering the shape, light, camera and programming will be explained.

Shape

A plexiglass dome was used to attached the LEDs to. A wooden base is made for the stability of the dome and attachment to the background.
For the background, a wooden plate is used to attach the white paper background.

Different from the concept, the prototype misses a pivot point and handle to easily place the subject in the dome. Also, the camera is not integrated into the main body, but placed in front with a tripod. The limitation is the movement of the camera over the spine, which is not available. However, this will not be a problem for testing the camera in the prototype.

Camera

For the prototype a Canon 550D is available to use. This covers the characteristics of the camera for the real light studio. Canon 550D is a DSLR camera and will be placed in the system mode.

Light

The LEDs in the prototype are controlled individually by Arduino software (chapter 8.2). To achieve this, the LED needs an input port. There is only one suitable RGB LED strip. The Neopixel LED strip (WS2812B) (Figure 58) has this input port and is used for the prototype. The light intensity is 16,6 lumen per LED. The colour temperature depends on how the Red, Green and Blue (RGB) are controlled in the Arduino. This also affects the CRI. Therefore, there are no values for these elements. Because of the high light intensity of the LEDs, it can be said that this LED strip is good for a test prototype.
In Figure 57, two test photos with the Neopixel LED strip are shown. After some editing, the colour temperature is good and it communicates the subject well.

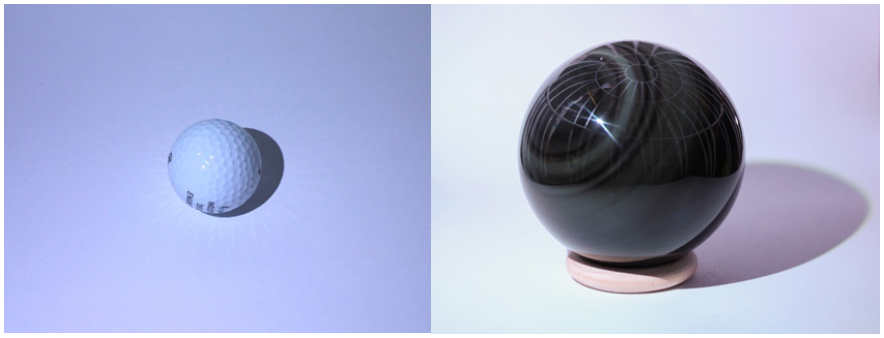


Figure 57, Two test pictures of the prototype studio. The colour temperature of the right photo has been changed in Photoshop.

Figure 58, Neopixel ledstrip used in the protoype. (Conrad, w.d.)

Programming

Different from the real light studio, the prototype will have a simplified layout from Processing with six sliders, three for the key light and three for the fill light, and a button for diffuse light to control the LEDs. Appendix D shows the codes of Processing and Arduino. The real interface is made in Photoshop and controlled via Adobe XD.

Also, the camera software will not be integrated into Processing. During the test, the camera software will be used besides the Processing software, Figure 59. Further explanation about the interaction during the test will be given in chapter 9.

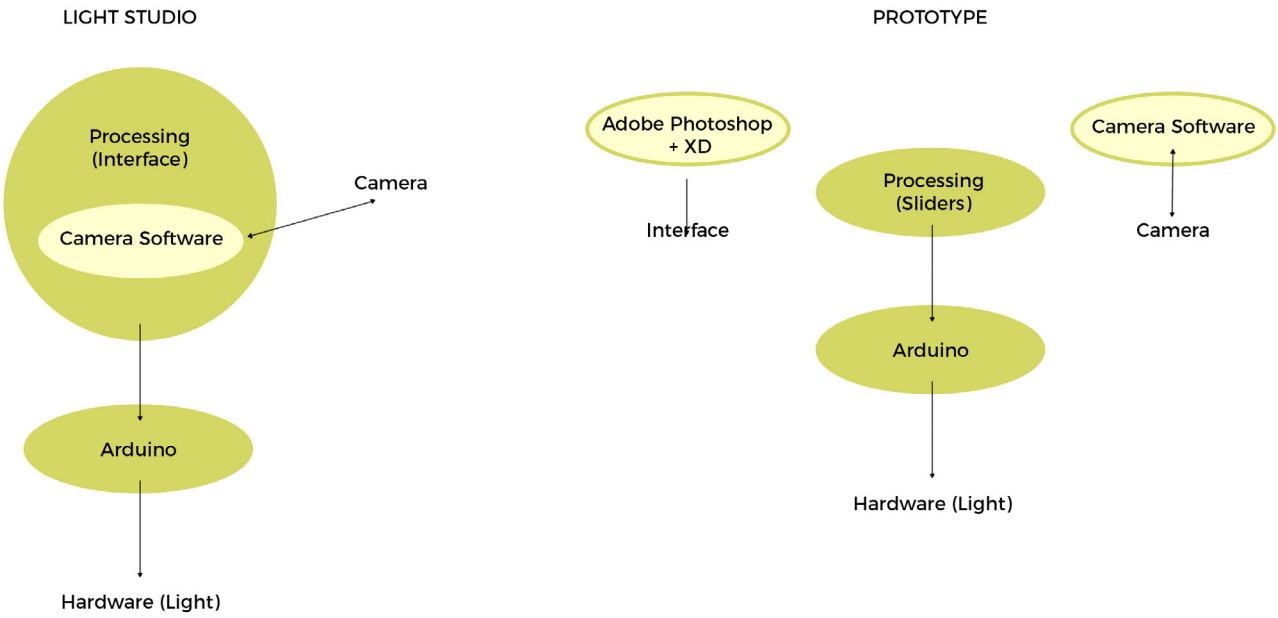


Figure 59, The difference in programming software between the concept and prototype. In the light studio, all the software elements will be integrated into the interface. The prototype will test the elements separately from each other.

Figure 60, Building process clockwise. First started with creating the icosahedral structure for LED placement. Then, soldering LEDs and attaching them to the prototype. Finally, placing all components (light studio, camera and interface) of the prototype together.

FURTHER DEVELOPMENT

After the conceptualisation and complete development of the concept and prototype, the idea is tested with students of IDE. The group was separated into experienced and non-experienced in photography and different conclusions came out of the test. With the results, a final redesign is made and recommendations are given for further development of the light studio.

9. USER TEST

A user test is done to receive valuable information about the interaction with the product and the intended user – students of IDE. First, the setup is shown with the method, participants and procedure of the test. Afterwards, the results and a brief conclusion will be given.

9.1. Set-up

To investigate whether students will understand the concept and the steps they need to take to capture professional photos, the following research question is made from the design goal.

> *"Which elements of the developed concept serve the student by helping them to understand the steps to take to produce a professional product photo, while letting them feel confident and enjoy the last step of the design process?"*

The elements of the developed concept are: general use, the interaction with the different lights and placement, camera settings, photo editing and the additional information (see Table 3 for more details).

Sub-questions

- On a scale from 1-7, is the concept understandable?
- On a scale from 1-7, does it have clear steps?
- On a scale from 1-7, does the student feel confident while using the concept?
- On a scale from 1-7, does the student enjoy working with the concept?
- Does the concept make the first step to photography easier?
    - o Would they use the product again?
    - o What is their first impression?
- Does the concept let student understand photography (the use of the camera & lights)?
    - o Observation sheet: which steps go well/wrong?
    - o Questions in between: Do they understand the information that is given?

The scores of the Likert questions need to be at least a 5.6 or higher (= 80%) to meet the design goal. The goal of the user test is to find out which elements of the concept are in line with the design goal

General use	Understanding connection between light studio, camera and interface
	2D – 3D view > changing effect of light bars, camera settings and editing
	Understanding the reading order of the interface
	Navigating through the interface
Light interaction	Understanding light and how it influences the subject's appearance
	Working with and understanding the light bars
	Difference between key, fill and diffuse light
Camera interaction	Understanding of the camera settings (auto- and manual focus, ISO, aperture, shutter speed)
Photo editing	Clarity of live editing
	Understanding of different editing functions
Additional information	Clarity of finding a specific topic
	Clarity of information

Table 3, Testable elements of research question

9.2. Method

The user test uses quantitative and qualitative research in which the observations, Likert scales and interview questions are used for analysing the data. Here the stimuli, participants and procedure of the user test will be discussed.

9.2.1 Stimuli

The stimuli shown in Figure 61 consisted of (1) the light studio, (2) a tri-pot, (3) laptop with the interface, (4) DSLR camera with zoom lens, (5) phone for recordings, (6) Arduino UNO for communication from laptop to light studio, (7) first test object, (8) second test object, (9) Likert scale question form, (10) consent from allowing audio recording and rights for the participant, (11) observation sheet, (12) procedure per participant, and (13) interview questions.

One of the two objects is placed in the light studio. This object represented one of the three different shapes (cube, cylinder and sphere) and one of the two different materials (matte and specular).
The tested variables were two glossy cubes, one specular cylinder, one matte cylinder, two matte spheres.
Every participant received one of the six tasks to work on during the test.

Figure 61, Stimuli used during the user test. (1) light studio, (2) tri-pot, (3) laptop with the interface, (4) DSLR camera with zoom lens, (5) phone for recordings, (6) Arduino UNO for communication from laptop to light studio, (7) first test object, (8) second test object, (9) Likert scale question form, (10) consent from allowing audio recording and rights for the participant, (11) observation sheet, (12) procedure per participant, and (13) interview questions.

Differences intended concept and prototype
The prototype made for the user test has some differences with the intended concept interaction. Firstly, the interface of the prototype is visually the same as the intended concept, but there is no working connection with the hardware.
Furthermore, the used LEDs in the prototype give less brightness and therefore less quality of photos than the intended concept.
Lastly, the photo editing is not integrated and only changeable with a single setting. The fixed image in the interface will change to give the participant some feedback on the editing.

To create the same interaction in the prototype as intended in the real product, the hardware and live image from the light studio were placed in another tab of the laptop (Figure 62). When e.g. the participant started interacting with the non-functioning sliders in the interface, the facilitator guided the participant to the workable sliders and live image. In this way, the participant could test the interface and find the information about light, camera settings, and photo editing and interact with the interactive live image and sliders. In this setup, the interaction is separated, but it will be represented in real use.

A difference which needs to be taken into account when analysing the results, is the camera setting. In the interface of the concept, this will look different than on the interface of the Canon software. Students might have some problems with finding and changing the right settings. In this case, it is more important to see whether the student understand the settings through the interface.

9.2.2 Participants

Six students of IDE participated in the user test. These students were selected on the amount of knowledge they had of photography. The students were separated into two groups, experienced and non-experienced. Students who did a photography workshop (or comparable) or practice photography as hobbyism were placed in the experienced group. Students who only use a phone for photography or have very little experience with photography and working with a DSLR (or comparable) were placed in the non-experienced group.

During the analysis, these groups were separated to find the difference in understanding and interaction with the product.

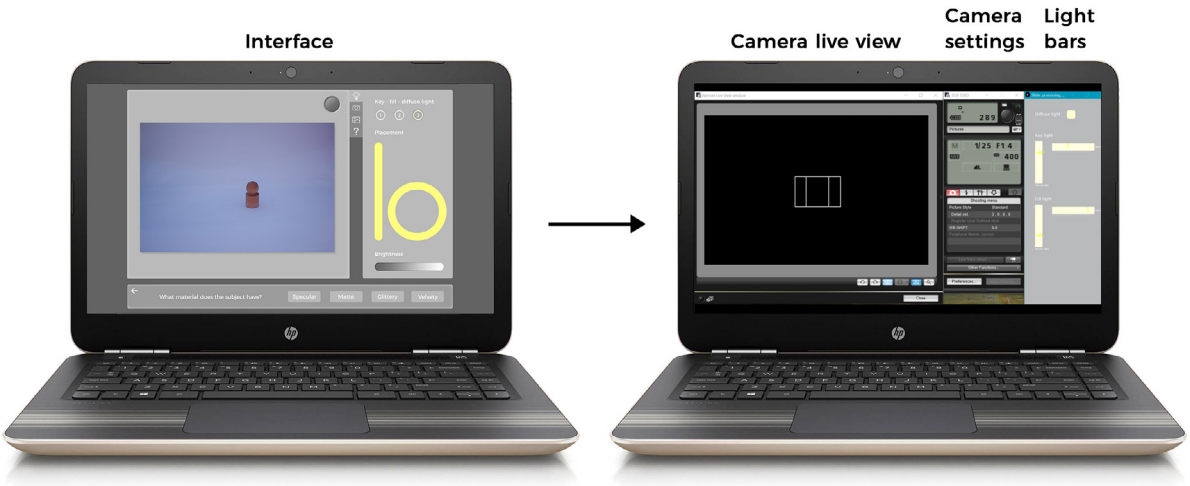


Figure 62, One laptop screen is changing between the interface and interactive parts (live view, camera settings and light bars.

9.3.3 Procedure

Participants were welcomed at IDE where they did the test in the same room. On the left, the light studio was placed with the camera in front (Figure 63). The participant was sitting on the left chair behind the laptop to interact with the interface. The facilitator was sitting on the right. In an introduction, the participant received information about the test and what product they were photographing. The participant was asked to think out loud while interacting to understand his thoughts during the process. After the introduction, the participant interacts with the interface by answering the questions first. When arriving at the interactions with the sliders, the participant was guided to the workable sliders to interact with those. He could place the lights in the (for him/her) most informative direction.

After that, the participant received one of the two tasks to interact with the camera settings. These tasks were:

- Use the right camera settings for capturing a movable object in focus.
- Use the right camera settings to capture one specific part of the product in focus with a small depth of field.

This could be achieved by the information given in the interface.
As a last step, the participant could edit the image in the interface.

A detailed procedure of the tasks per participant can be found in appendix F.

Figure 63, Test setup. The light studio is placed on the left with the camera in front. The laptop with interface is placed on the right. The participant was sitting on the left chair and the facilitator on the right chair.

9.3. Results

All results from observation, Likert scale (appendix H) and interview are separately processed per participant and can be found in appendix I. These results gave insights on the ease of the interaction or problems that occur. First, the Likert scale questions are processed. The Likert scale of Figure 66 gives the mean values of the experienced and non-experienced group. The groups are processed separately due to the big differences in the mean values. By separating the scores, problems can be seen in the non-experienced group which otherwise would disappear. The limit value set on 5.6. The mean values of the experienced group are above this limit, except receiving new knowledge. This is understandable because they already have experience and knowledge. More importantly, is how they value the use and interaction. Therefore this score is left out of the discussion and iteration.

The non-experienced group, however, scores negatively (mean value < 5.6) on the clarity of steps, confidence while using and feeling of being in control while using the product and positively (mean value > 5.6) on receiving new knowledge and how enjoyable they like the interaction. The negative scores need to get a closer look to understand the problems that occur during the interaction of the concept, which will be done with the observations sheets and interview answers.

Table 4 shows an overview of all the notes taken from the observation sheet and interview. The notations were observed several times for different participants. This amount is placed in front of the notations. Notations that noted several times are highlighted. These will be discussed.

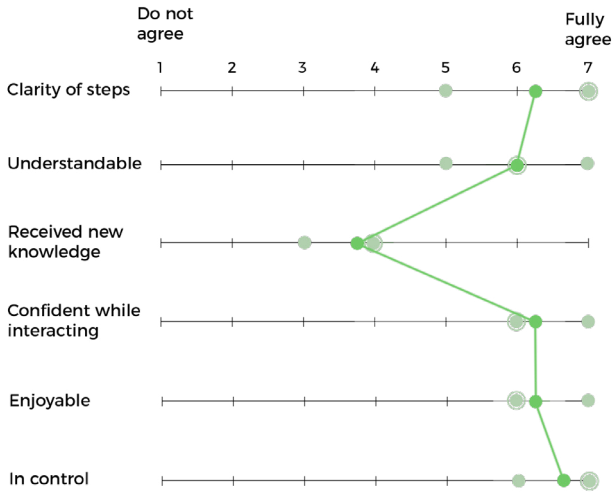


Figure 64, Likert scale experienced participants including individual answers.

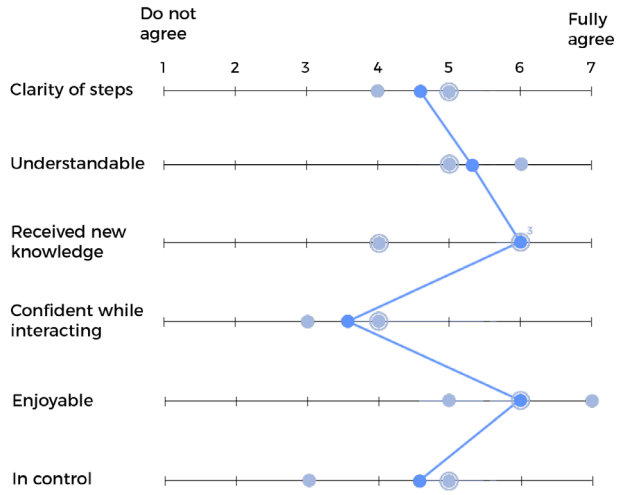


Figure 65, Likert scale non-experienced participants including individual answers.

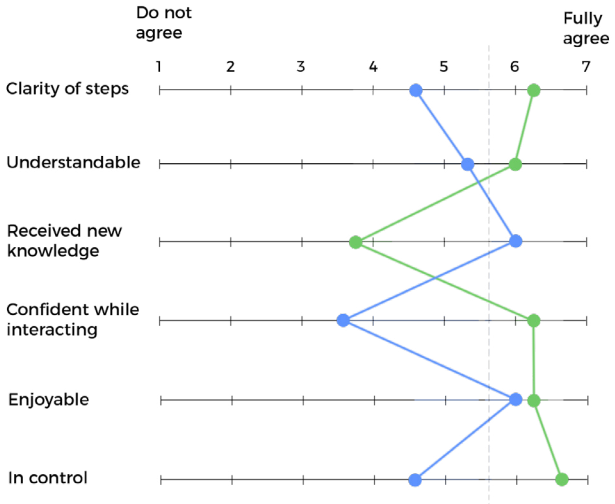


Figure 66, Combined Likert scale experienced students and non-experienced participants

Four of the six participants did not read the information or did not see the information at the bottom of the screen. This influenced the lack of understanding of the different lights. Besides, the editing was also understood in two different ways. Two participants saw the editing options as camera settings and two thought that the image was already captured before going to the editing.
Furthermore, the rotation and height of the sliders were not clear for three participants. This gave them less control over the placement of the LEDs. Also, two participants wanted to change the camera settings on the hardware camera instead of the digital interface. It should be more clear what the options are in the interface.
Also, there is no real contact with the hardware camera and light studio. This might be caused by the test setup. Rotating and moving the camera was difficult and placing an object was not integrated into the interaction while placing was difficult by not lifting the dome. However, in the redesign, more interaction can be motivated by the product.

Participants were enthusiastic about the direct feedback from the live image. Through this, they easily could see what the image would look like before capturing. All participants wanted to use the product again since they thought it was fun to play with while finding the right light composition and it makes it much easier than setting up the scene by themselves.

In the interview, some advice was given to improving the concept. One student advised adding a third light. It is not always needed, but better when it is integrated. Also, some questions came in mind of the participants that needed to create a longer light. It was not clear how they could create this. Another question was how to deal with multiple shapes. The interface needs some more information about that.
One last note from two participants was to let the shutter button tracks more attention by increasing the contrast or using another colour.

Amount of participants	Positive
1	Understand key, fill and diffuse light
2	Fluent change camera settings
1	Look inside light studio to see the real colour of the product
3	Direct feedback
1	Easily navigate with sliders
	Negative
1	Less control over sliders
3	Do not understand height and rotation of sliders
2	Changing settings on hardware camera instead of in the interface
1	Sliders of editing too small for finger
2	Too much information text
4	Not reading/finding information
4	Do not understand key, fill and diffuse light
2	Seeing editing option as camera settings
2	Thinking editing is after capturing image
	Possibilities
	Three point light
	Key and fill light need to be seen as one
	Creating long light? What about multiple shapes?
	Shutter can be more clear, attracting attention

Table 4, Overview of notes from the observation sheets and interview.

9.4. Conclusion

A user test is done to answer the research question “Which elements of the developed concept serves the student by helping them to understand the steps to take to produce a professional product photo while letting them feel confident and enjoy the last step of the design process?”

Six IDE students participated in the test. Three of them were non-experienced and three were experienced with photography. Form the quantitative research could be concluded that the experienced participants had a positive mean value on all topics, except learning new knowledge. This is explainable by their knowledge of photography.

Non-experienced participants had negative mean values on the understandability of the steps, confidence while using and being in control. Not reading or seeing the information was the biggest problem which causes these negative values. The redesign needs to find solutions on these points to improve the interaction.

There were some limitations of the prototype which could influence the results of the test. The sliders in the interface were non-functioning as well as the live image. In this way, the visual feedback of actions was not always visible and causes some confusion. Besides, the interactive sliders and camera settings looked differently and the facilitator sometimes needed to give some explanation during the test.

Redesign suggestions:

- Create more connection between light studio, camera and interface
- Better explain light placement
- Give more visual information
- Information should track more attention.
- More clarity about key, fill and back light.
- Rethink editing option. It might be better to use it after capturing the image.

10. REDESIGN

During the user test, some interactions were found that needed an iteration. This chapter shows new ideation on the concept and the final design.

10.1 Hardware

Connection between interface, camera and light studio (interaction with light studio and camera)
Till now it was not clearly stated how to lift the dome, where the interface is placed and how the background is attached and detached.

The dome
The dome is made of opaque black hard plastic. This prevents environment light to come inside. An inner white translucent cap can be placed inside the dome for creating soft light. This will also be helpful for high specular materials to prevent reflection of the environment.
For placing a subject in the product, the dome can be lifted. Handles in front will indicate the possibility of lifting the structure. On the back, a hinge will facilitate the rotational movement.
A hole is made in the dome for the camera to move up- and downwards. A structure keeps the camera in place.

Background
The background is rethought. In the prototype, a wooden background was used to attach the white paper background. The problem was that the lights behind the shelf were not visible. When this would be transparent the lights can go through the background sheet.
A solution is found for quickly attaching and detaching different coloured backgrounds. Every background sheet has two metal open rings. These rings fit into two pins. These pins have a stop where the metal rings of the background sheet will be blocked and the sheet will fall downwards and curve to the bottom (Figure 67).

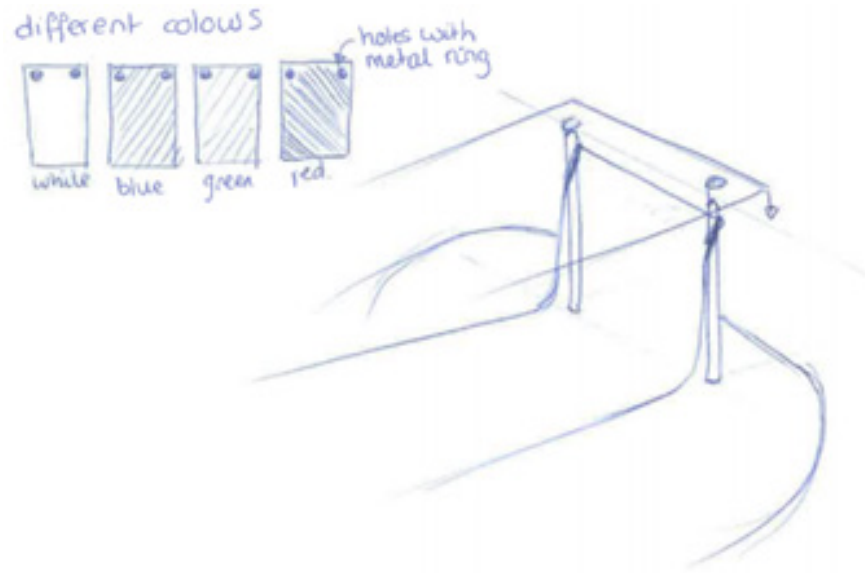


Figure 67, The background will be attached to two pins and is available in different colours.

Interface screen
For the screen placement, several things are thought out. The screen might be placed in front of the gab. This might increase the interaction with the 2D and 3D scene. However, lights coming from the light studio might be too bright and make the screen less visible. Especially with editing of the image, a neutral light environment is needed. The screen will, therefore, be placed beside the light studio on a laptop screen. This laptop is movable, so the student can place it on any preferred place.

Location of the light
To give the student a better understanding of the placement and location of the light, two different solutions are found.
Firstly, instructions are placed on top of the sliders. These are 'Height' and 'Rotation'. In the first concept, only 'placement' was written above the sliders which did not give the right instructions.

Furthermore, to increase the understanding of where the light is located at a certain point, the light studio will have low illuminated LEDs on the outer side of the studio. These LEDs will show where the light is located and give a better understanding of the movement of the light around the subject.
It will also increase the interaction between the interface and light studio.

Figure 68, Final product. Lights on the outside will indicate where the light is located. A hinge will make it possible to easily place a subject inside.
A softbox cap can be placed inside for diffuse light.

10.2 Software

Informative location for information
The guide bar in the bottom of the interface did not receive enough attention and there was too much text to read. Therefore, the guide bar will be removed in the new interface and information will be given in other ways.
The questions that the program asks at the beginning about the shape, material and colour will be placed as a new tab in the list. It will be the first screen that the student will see. While answering the questions, the answers stay visible and give an overview of the given answers, that can easily be changed. While answering, the light studio will change the lights in order to give information about the placement of the light. When moving over an answer button, a pop-up underneath will give short information about light placement for that specific answer.
The separated tab is an advantage for experienced students or students that have already worked with the product before. They do not have to go through the process of answering questions, because of the knowledge they already have. They can go directly to the light and camera settings if they prefer.

Information given with the lights of the light studio and camera settings will have the same pop-up while sliding over the buttons.

Visual information
The information that is given in the first concept consists of text. More visuals are needed to be added in the interface. First, visuals in the questions are added. Under the shape question, shapes are placed with name and visual. The same is done for the material.
Information with the key, fill, back and diffuse light is already visually seen in the live image. Besides, a pop-up sliding of the light button will provide a visual that illustrates what the light is used for.
The same is done for the photography part. Here, sample images are given to give a brief and quick explanation about the function.

In the information part, the live image will be overlaid with sample images that give a more informative explanation and support the textual information.

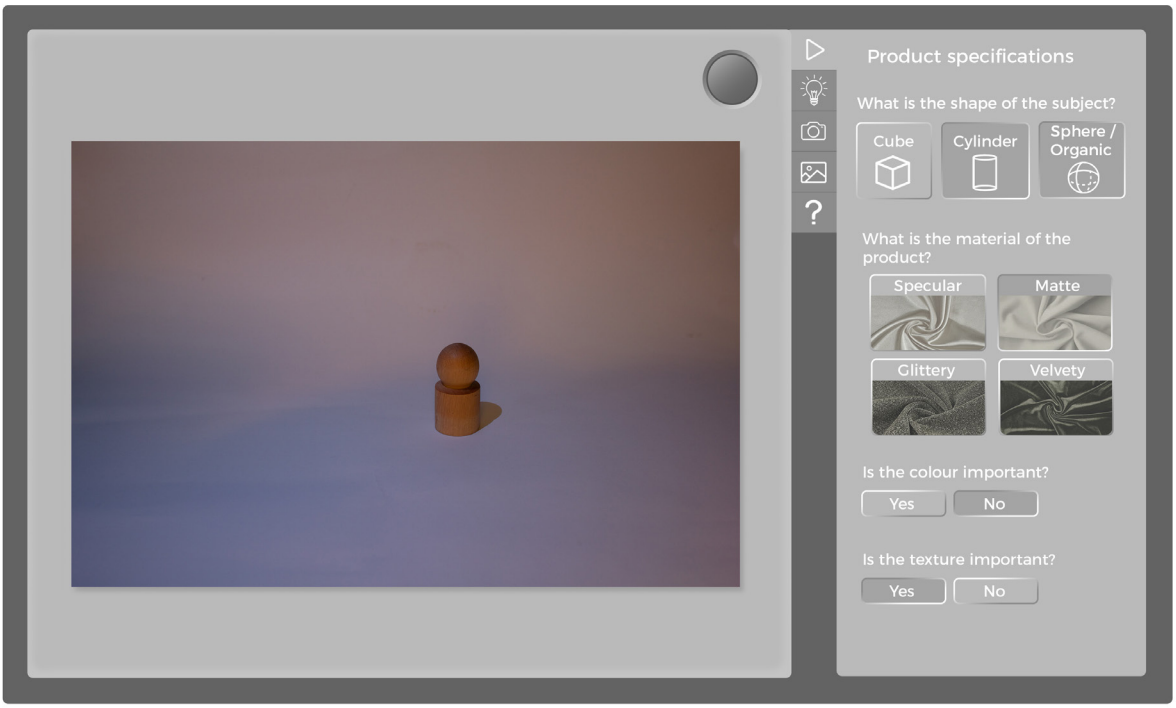


Figure 69, Questions are relocated to a new tab. Clicking the button will press it down and in this way give an overview of all answers. Multiple answers are possible on one question. The live image changes according to the answers to give a suggestion and visual information. Sliding over an option gives some textual information about the light placement.

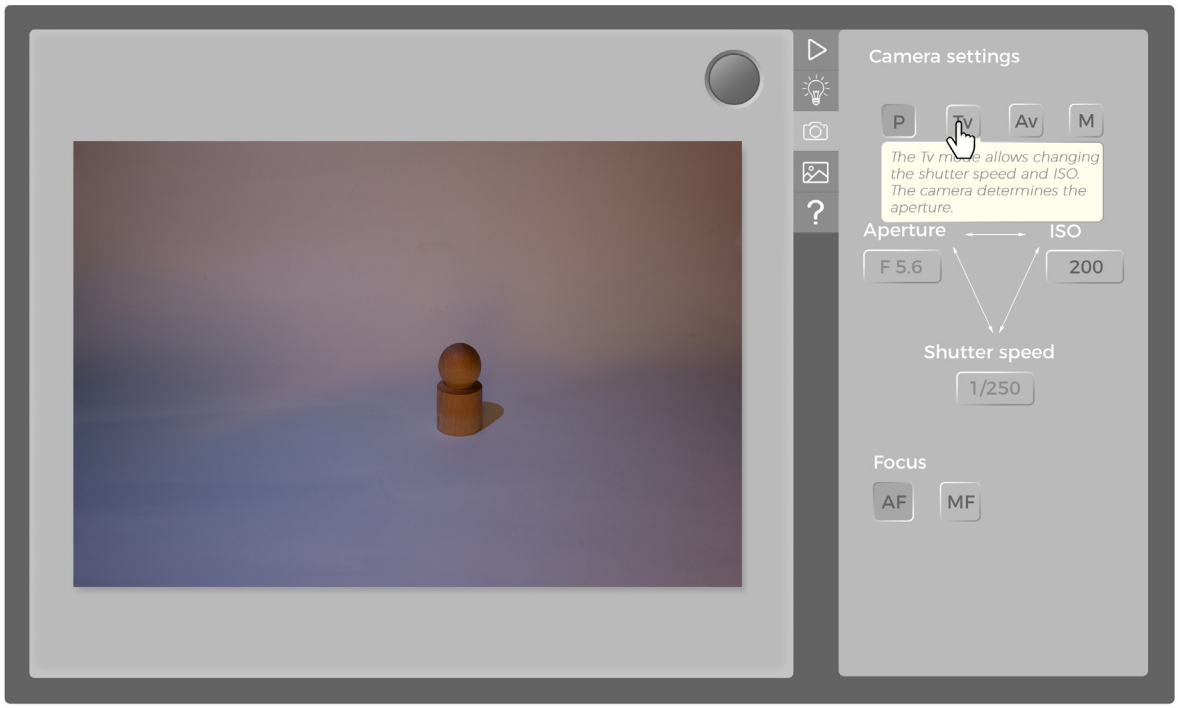


Figure 70, The camera has different options, which can be chosen by the student. While sliding over an option, information will be provided by a pop-up.

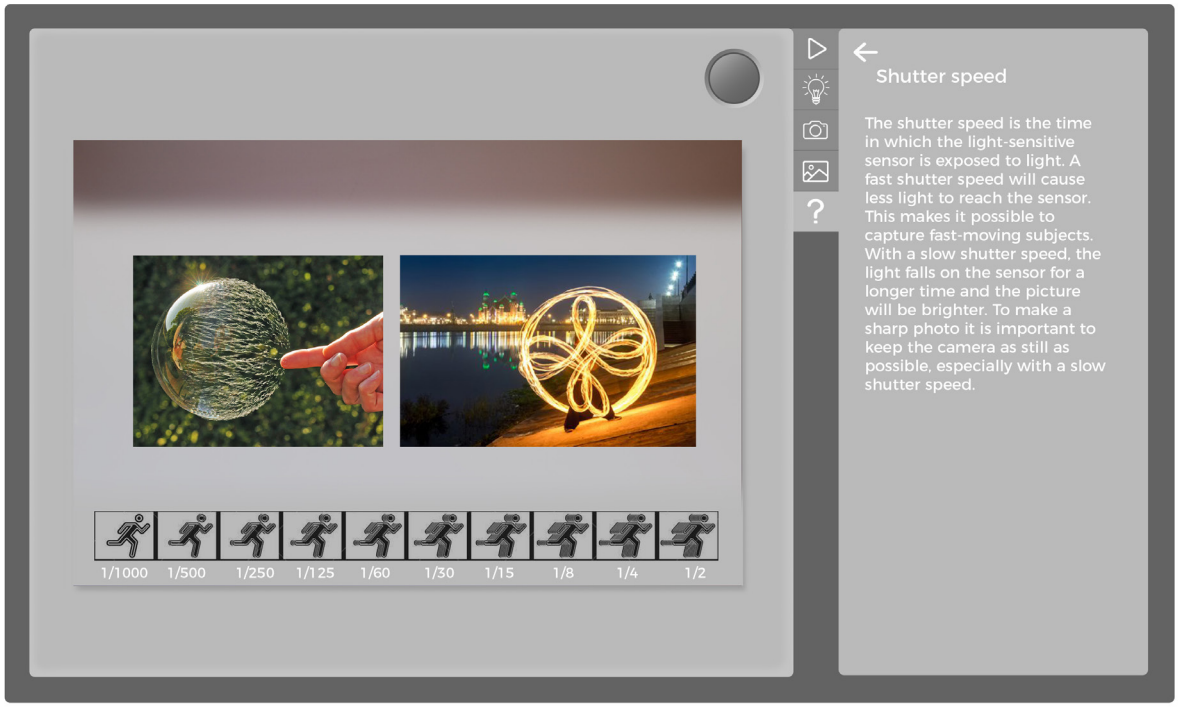


Figure 71, In the additional information tab the student can find information about light placement, types of light and camera settings.

Connection key, fill and backlight & clarity about which light belongs to which sliders
A better connection between the key, fill and backlight is needed to separate it from the diffuse light and see it as one scene. Some ideation (appendix J) on this is done and the final design is made. The key, fill and backlight are placed next to each other and are outlined to connect them. The buttons are bright yellow to white and will be coloured yellow when they are activated. A darker outline indicates that that specific light is active and can be changed by the sliders. When clicking on another light, this one will also turn yellow and the dark outline will jump to that specific light. The last light will stay yellow to communicate that it is on. It can be turned off by clicking on it again. The buttons are pressed outwards to indicate that it is a button. By clicking on it, the button will be pressed inwards. Going to another light will release the button again and it will go upwards.
Clicking on the diffuse light will deactivate all the other three lights. Turning the diffuse light off lets the interface return to the last setting of the key, fill and backlight.

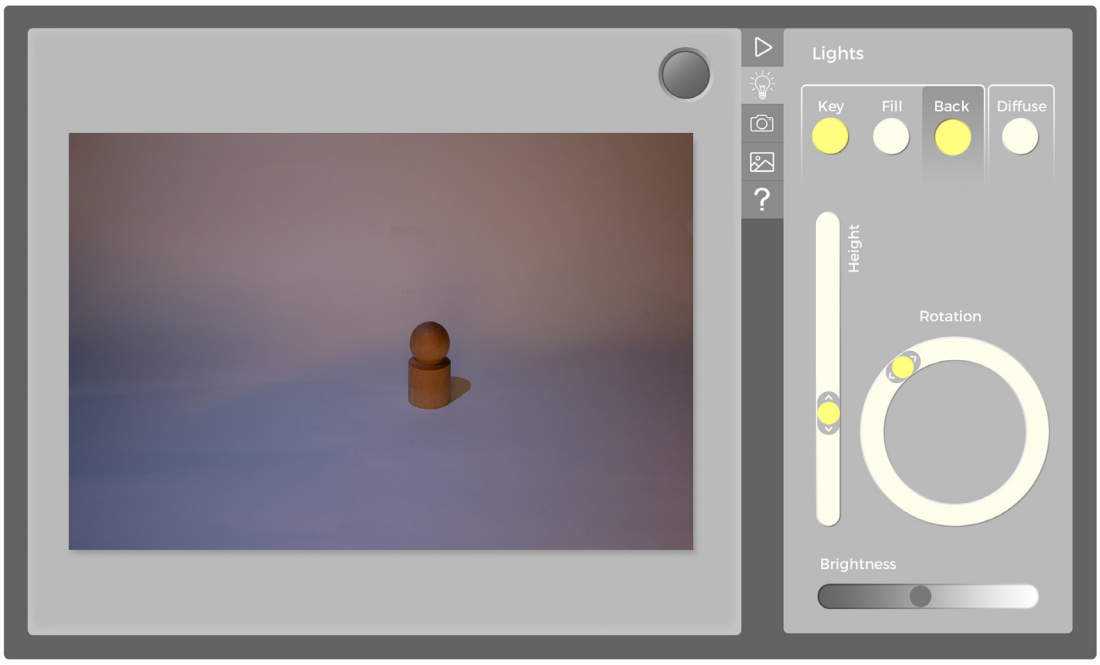


Figure 72, Key light and back light are both on and back light is available for changing.

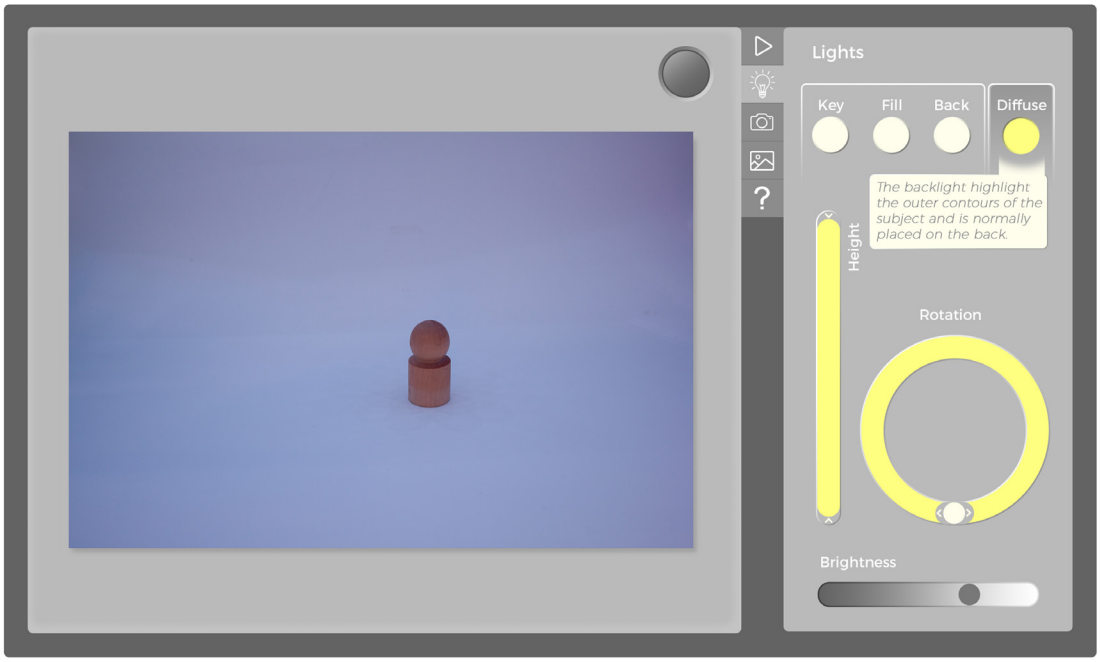


Figure 73, Diffuse light on with information by sliding over the button.

Creating a "long" light
In the sketches of Figure 74, the ideation is visible to clarify how to turn on more LEDs along one axis and in this way create a longer light than a single focus light.
The slider will have a start and end, which creates a dot when they are at their nearest. Moving them away from each other will increase the length of the light. Arrows will give the indication to move in a certain direction.

The complete final interface can be found in appendix K.

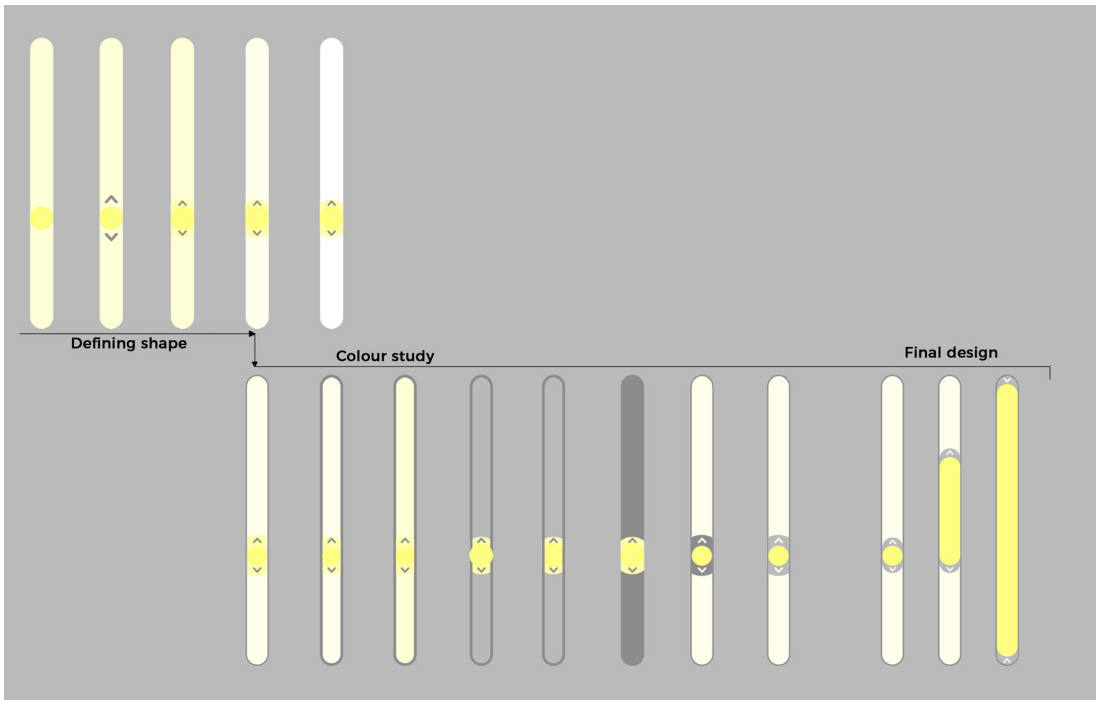


Figure 74, Ideation of sliders

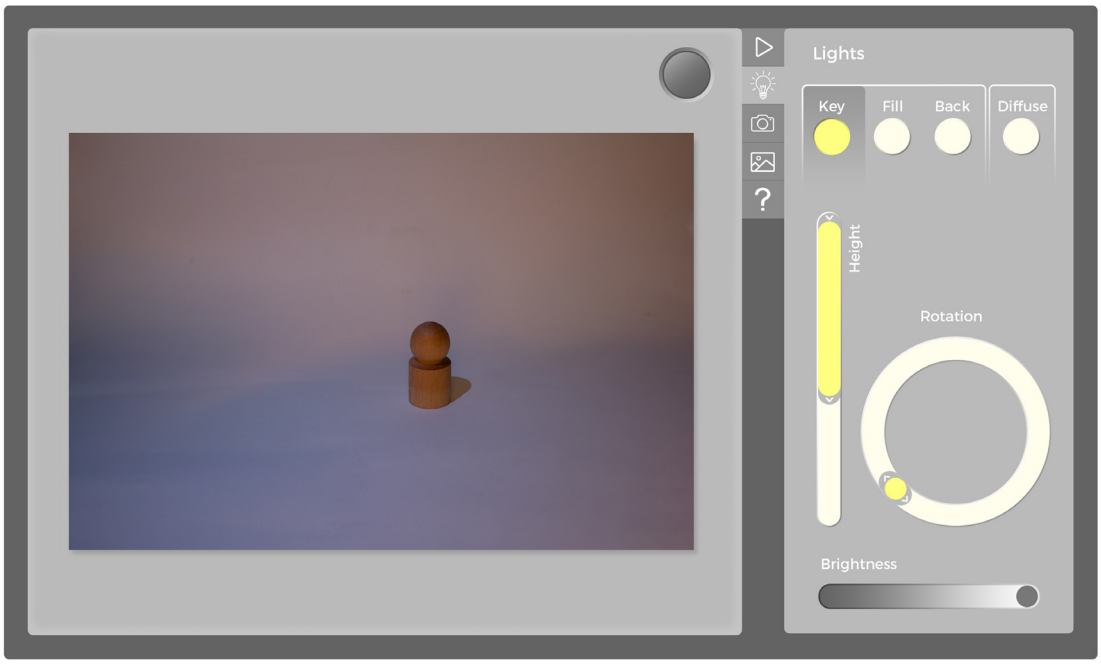


Figure 75, Sliders in the final interface

11. DISCUSSION AND RECOMMENDATIONS

In the research part, information is given for implementation in the concept. A section that can broadened is the editing options. Now, the focus lies on the colour and contrasts which can be extended with the sharpness of an image and compensating lens deformation. In the interface, this can be added through different tabs in the editing tab, Figure 76.
The prototype made for the user test faces some limitations in testing the interaction. The biggest difference is the missing live view in the interface. This live view was visible on a separated screen and gave feedback when the light sliders were changing. However, the separated interaction causes some confusion in the understanding of the possibilities of the interface. Also, the 'sliding over' function in which a student would receive information while sliding over a button or setting was non-functioning. Instead, they had to click on it before receiving the information. Some participants did not receive any information, because they did not click on the targets.
For a second user test, it is recommended to make a fully workable interface with integrated live image, workable light sliders, camera settings, editing options and slide over information pop-ups. This will give a reliable view of the interaction and possible redesign options.

Besides, the concept starts with giving suggestions for light position when answering the questions. This software connection needs to be made, which consists of communication with the interface in Processing and Arduino.

Throughout the process of taking a photograph with the light studio, there is little attention for the right viewpoint of the subject and camera. This is due to the focus on light and camera. In a new iteration, this new focus can be added.
The same goes for environmental colour differences in product photography. A student could look at what the intended placement of the subject is in order to give different colour temperature and illuminance.
Keeping these two additive options in mind, the product still has to meet the demand for clarity without complexity.

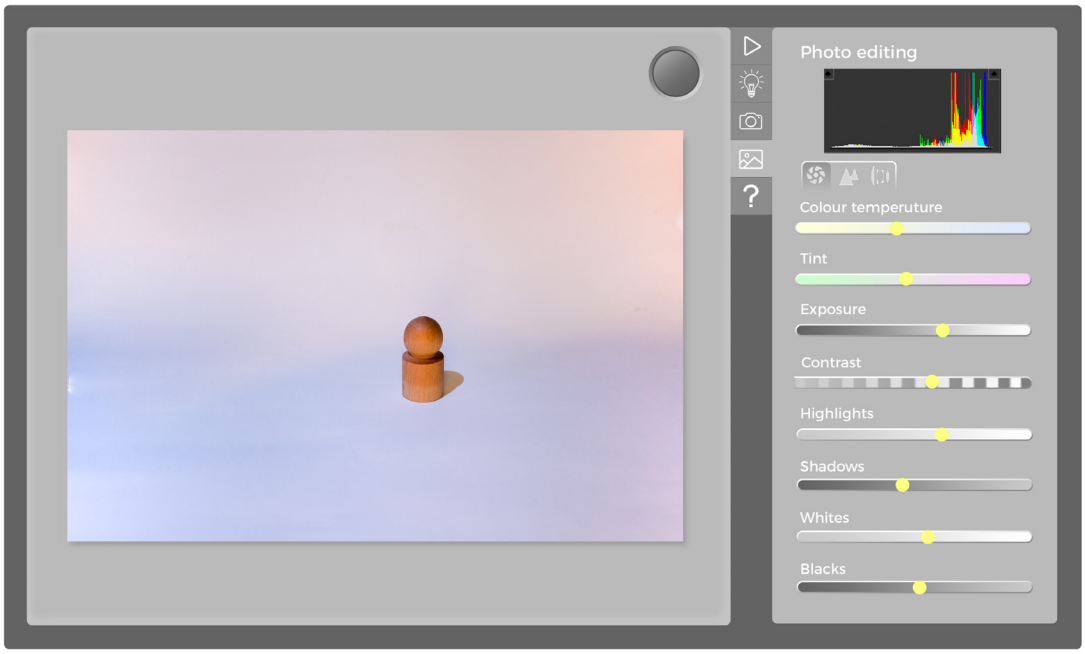


Figure 76, Possible design for photo editing.

CONCLUSION

This report has shown the design process of the development of a concept solution for the defined problem. Students of Industrial Design Engineering (IDE) create products through a design process they learn throughout many courses. This process ends with presenting the product, by making photos of the final design. However, the lack of attention for the last presenting part leads to unprofessional photos. Therefore, the design goal of this project has been to let IDE students understand the steps they need to take for photographing. Thus, they will feel confident and motivated to photograph their products in a professional way.

Through research, conceptualisation and further development, a final concept has been designed to meet the demands of the design goal. The light studio has a dome-shaped cover in which high-quality white LEDs are placed in an icosahedral structure. A system camera is integrated into the dome structure. The subject can be placed in the centre of the studio with a variety of background colours. The student can operate the interface on a laptop to control the placement of the light, change the camera settings and edit the image instantly. The camera constantly shows a live view of the studio, enabling the student to monitor the 2D image while changing the light position.

Results of the user tests showed that students were enthusiastic about the live feedback. The live feedback made it possible to track the changes of light positions and camera settings, which is difficult to see on a small camera screen. Besides, they appreciated the clarity of the camera settings, which were supported by information, but are normally hidden in the camera itself. Despite a well thought-out conceptualisation, the user test showed some unclear elements within the interface. These were mostly due to insufficient or non-visual information and unclear design elements. These shortcomings were analysed and redesigned for the final concept.

The final concept is in line with the design goal. Students were eager to use the light studio and felt motivated to create professional photos of their products. By making these professional product photos, their quality of work will increase.
An element of the design goal which can be refined, is the understanding and clarity of the information given in the interface. A redesigned final concept is presented to conduct a second user test. However, it is recommended to create a new prototype in which the live image, sliders for the light placement, camera settings and editing options are all working within the interface, before conducting this second user test. In this way, the complete interaction can be tested and evaluated. With these final adjustments, the product will be ready for the market.

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APPENDIX

APPENDIX A - COLOUR IN DESIGN

Colour is all around us. Colour is light from the sun or an electrical source that is perceived by the human eye. When light falls on an object, it will absorb part of the light spectrum and reflect the specific colour of the object. The human eyes can only see a part of the light spectrum, Figure 77. To get an understanding of what we see, this chapter will explain the basics of colour and its perception by the human eyes.

Colour theories

For many centuries people have tried to get a better understand of colour. Especially the communication was one of the important motivations for it. Because, how can someone communicate what colour he means? Green can be light green, olive green or yellowish green. In search for more understanding different theories appeared.

One of the first explanations of colour came from Isaac Newton and is called the Newton's seven. It describes a seven colour range by looking to the natural phenomenon; the rainbow. It is explained in a straight line like the visible light spectrum in Figure 77 (Best, 2017). However, this way of explaining, categorising of colours can be challenging because only the hue (full colour) could be placed in the line and not, for example, a lighter version of that colour. Therefore, the colours were placed in a circle, Figure 78. Later, more colours were added in the colour wheel and created an equal amount of colours, Figure 79. Through an equal amount, complementary colours appeared (red-green, blue-orange, yellow-purple).
With this colour wheel it was possible to make the lighter and darker colour visible in two pictures.
The colour wheel in Figure 79 shows a triangle in the middle of the circle pointing towards yellow, cyan and magenta. These colours are called primary colours. With these three colours it is possible to create every other colour in the colour wheel. These primary colours are used for subtractive mixing, Figure 80. Subtractive colour mixing is used for painting, starting with white and adding colours. Light mixing, or additive colour mixing, has other primary colours: green, blue and red. Additive mixing starts with black and adds different light colours to finally create white. (Verity, 1980)

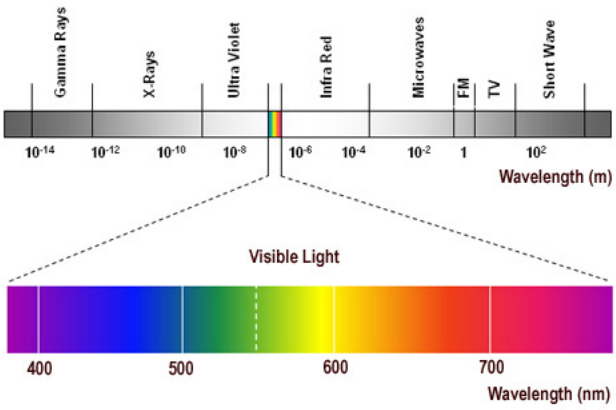


Figure 77, Light spectrum (Bor, 2018)

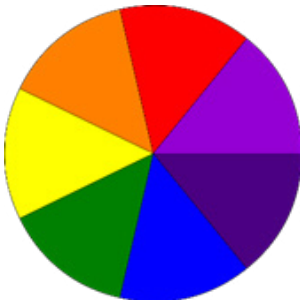


Figure 78, Newton colour wheel (Wikipedia, 2016)

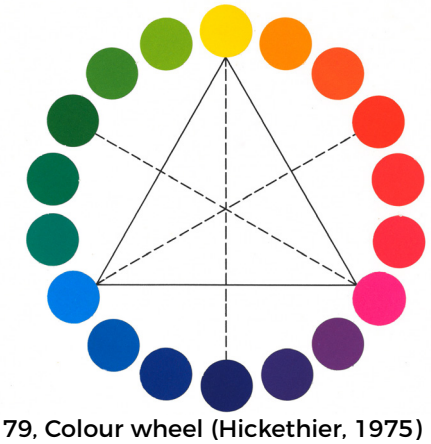


Figure 79, Colour wheel (Hickethier, 1975)

From these two-dimensional perspectives, people started making three-dimensional models, which were able to describe the different gradations of white and black in the hue. One model is the Munsell model, Figure 81. Going upwards and downwards the colour becomes more white or black, which is the value of lightness. Going from inside outwards, the hue becomes more saturated, which means the colour becomes less grey.

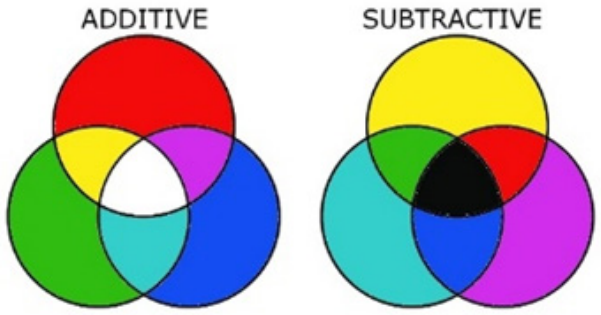


Figure 80, Two ways of colour mixing (Lucaskrech, 2010)

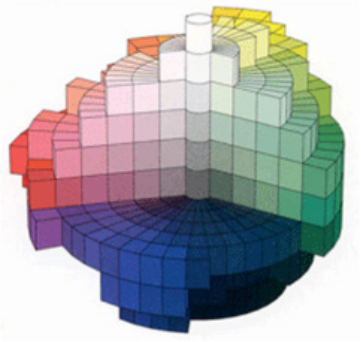


Figure 81, 3D colour wheel (Ciurej, 2013)

Visual perception

For a designer, it is important to have an understanding of the visual perception of the human eyes. When designing a product and presenting it afterwards, the designer wants his product to be perceived in the right way. The colour of the product is constantly perceived differently depending on its surrounding. On a cloudy day or with direct sunlight the colours change. Besides, every human has a different visual perception. No researcher has yet accomplished to create a computer that can look like a human eye does. (Best, 2017)

To get an understanding of how human eyes perceive light, this chapter will explain the different influences that the brain gets while perceiving colour.

The human eyes

The human eyes have two types of light receivers: cones and rods. Cones are able to receive high illuminance and colour. Rods let the human see with low illuminance, but without colour.

The cones of the human eyes can receive three types of colour wavelengths; long, medium and short waves, Figure 82. This Tri-chromatic Theory of Colour Vision was founded by Sir Thomas Young in 1801 (Verity, 1980). These colour wavelengths create the visual spectrum of the human eyes. The overlap of the different wavelengths can be compared to the additive colour mixing with light and explains why there are three primary colours (three wavelengths) needed to make the whole colour range.

The cone of the eyes creates one luminance (lightness) and two signals of the colours next to each other. In this way you can see a yellowish-green, but not a reddish-green. (Best, 2017)

As mentioned, the perception of colours is different for every person. This difference becomes bigger when one of the cones is disfunctional, also called colour blindness. The next paragraphy will futher explain this topic.

After image

With this knowledge in mind, it is possible to understand the different visual perception effects that people see around them. A well-known example is when someone stares at a red dot for a few minutes and then looks to a white surface. He will see a dot in the complementary colour. Cones adapt to the stimulation of the red cone and become saturated, losing sensitivity for that colour. When looking at a white surface the saturated cones send to the brain a weaker signal than the others, and thus the opposite colour appears, a so-called “after-image” (Best, 2017)

Colour constancy

Another human visual perception is colour constancy. The colour of objects that we see around us change colour every time the light or environment changes. The brain is capable to understand the changing colours. For example, the brain knows when a white paper is white and not yellow or blueish. This is possible through the coloured objects in its surrounding. It can be difficult for the brain to understand the “colour filter” of the light at that moment, but he can make an estimation. In the example of Figure 83, A and B have the exact same colour. However, the brain makes an estimate of the pattern and believes that B is lighter that A. (Pickard, 2017)

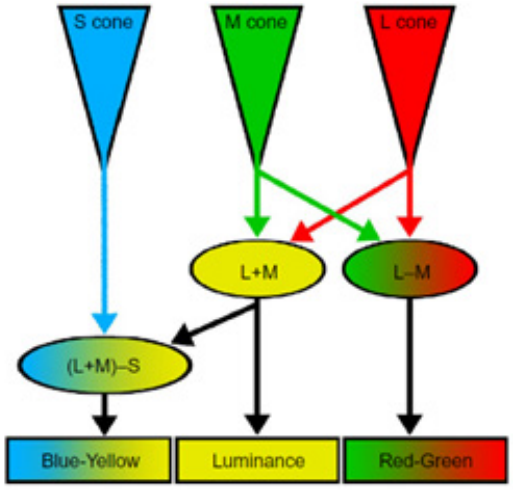


Figure 82, Three colour cones (Best, 2017)

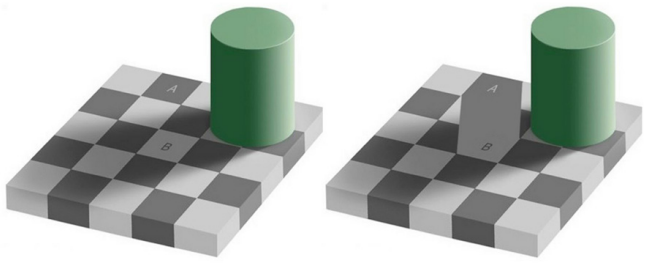


Figure 83, Three colour cones (Pickard, 2017)

Colour blindness

Every human has a different visual perception of the colours around them. However, we can say that most people have equally working eye cones and belong to the group of 'normal' vision. There are groups of people where some eye cones are non-functioning. This causes different colour blindnesses. One of them is a complete vision of black and white. Everyone can experience this by nightfall when colours fade and change in grey shades, because only the rods are working. Some people experience this at daytime and do not see colours. In other colour blindness, one colour wavelength is not perceived by the eyes which causes a different perception of colours. The different monochromatic colour blindnesses will be discussed.

Green-red colour blindness

With green-red colour blindness, the green and red colours are missing in the vision. Most of the people who have green-red colour blindness are men. This is because the defect is located on the X-chromosome and men have one of this chromosome. The colour blindness occurs when two genes on the X-chromosome unequally cross over which lead to a combined gene of the green and red cone. Because one of the green or red cone is not functioning, the red and green are not visible for the observer (Best, 2017). When the observer is not able to perceive red-light it is called Protanopia and for people who cannot perceive green-light, it is called Deuteranopia. However, the difference in vision is very small (Colour blind awareness, w.d.). Lighter versions of the green-red colour blindness where the green or red cone is less functioning than normal vision are called Protanomaly and Deuteranomaly respectively, see Figure 85.

When designing a product for people with this colour blindness it is good to use yellow and purple as this is the most attractive and visible colour combination.

Green-red colour blindness

In this rare colour blindness, the blue cone is not functioning. Blue appears green and yellow appears violet or light grey. This colour blindness occurs through a defect on the gene. The colour blindness is also called Tritanopia when the blue cone is completely non-functioning and Tritanomaly when the blue cone is less functioning (Best, 2017).

When designing a product for these people it is better to not place blue and red, pink and orange close to each other.

Elderly colour blindness

Over a lifetime, the eyes become less sensitive for colour and light. Most elderly visions get the blue-yellow colour blindness (Tritanopia). Elderly colour blindness mostly goes unnoticed. When people get older their blue-eye cone non-functions slowly over time. However, their eye lens becomes more yellowish. This makes the difference between a normal vision and colour blind vision smaller and mostly unnoticed. Colours will appear less intense and have some differences.

In Figure 84, normal vision, Tritanopia vision and elderly vision are shown. The elderly vision is created with the Tritanopia vision and a yellow filter.

Besides the colour blindness, the muscles around the pupil are getting weaker. This causes a decreased pupil size and eyes which are less sensitive for light. Bright colours become more greyish. When using pastel colours in a product or image, it can be possible that elderly cannot distinguish the different pastel colours. Therefore, it is better to use bright colours and no analogue colours beside each other.

(Wolters Kluwer Health, 2014)

Figure 84, Elderly colour blindness (Rhettandlinkommunity (2019)

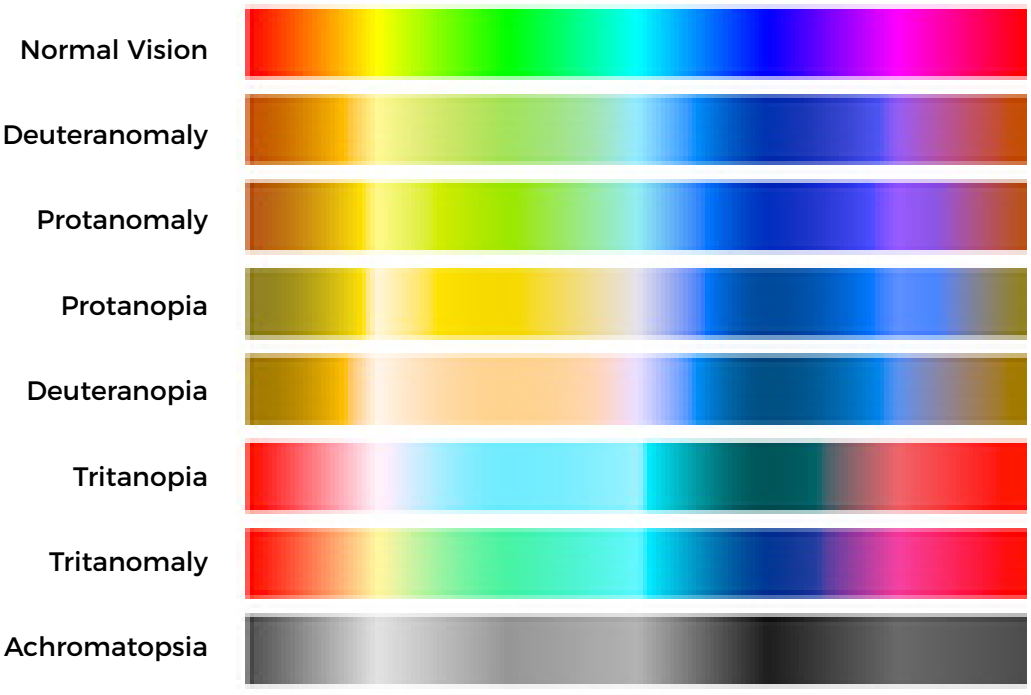


Figure 85, Colour vision of colour blindness (Wikipedia, 2019)

APPENDIX B - DAY AT STUDIO PRODUCT PHOTOGRAPHER THOMAS LENDEN

On Thursday I went to the photographer of NPK design, Thomas Lenden. He studied photography and is an expert in different kinds of photography like portraits and products. It was interesting to see his photography studio and learn more about making professional pictures.

In his studio, he normally uses a standard white background, because this is usually preferred by clients. This background makes it is possible to place all the different products next to each other on a website. The sheet that he uses is a plastic sheet, purchased from a photography company. When using paper, the structure that becomes visible in the photo needs to be removed in Photoshop. However, he uses paper for bigger products, because it can be thrown away more easy due to the lower costs.

For the set-up, he uses four lights which are placed on the top, left and right, and underneath the setting. The last one is used to make pictures without shadows. The top light is mostly used and sometimes he uses the left or right light or both. For every product, he determines what gives the right information.
In most cases, he uses softboxes. These lights create soft shadows and spread the light evenly. The boxes that surround the light have more length horizontally then vertically. For longer products, it is more interesting to have a single line going over the whole product. Thomas advised me to use long length lights, like a light bar of LED strip. This gives nicely divided light over a product.
Grids are used to create a spotlight. A normal light will always fade towards the sides. A grid will centre the light to get a higher focus.

The temperature of the flashlight he uses is daylight (around 5000/5500K). It not possible to use this light constantly to see the result, so therefore he uses a flashlight. Before making the picture the light gives a warm light in which a preview of the shadows and reflection can be seen.

The camera is placed on top of the scene and controlled from the computer. Normally he uses a large number for the aperture and a high shutter speed. The high shutter speed is needed because he uses the flashlight. For some settings, he uses a small number for the aperture to blur a part of the product.

It is not always possible to create every reflection and shadow in one scene. For this problem, it is possible to make two pictures and place them over each other in Photoshop and combine them. In this way, the shadow and highlight become visible in one photo.

When photographing something that is hanging on the ceiling, it can be rather challenging to get the right perspective.
As a solution, the product is photographed standing on a white sheet, just as any other product. The photo is turned around afterwards. Sometimes, lights are not working well and have to change. It can be challenging to think upside-down.

During the meeting, I noticed that every product has different needs. There is not one setting that is perfect for every product. Thomas showed me different products and with every product he told me the light settings, which were different every single time. For every product, it is important to look at its needs and look what fits best. In every setting, he makes use of at least two lights. With one light it is hardly impossible to create the preferred result.

With after editing, dust is one of the main time-consuming problems. There are some tips to prevent most dust, e.g. using high air pressure. There are tubes for sale with this high pressure. Besides, a glasses cloth is also possible to use.
Another thing to after edit is the background. This is also one of the most important things. In most situations, the background has to be removed completely. In this way, the client can place the product directly onto the website. Chrome is always edited afterwards. White and black lines are placed on places where it looks naturally. It is quite impossible to create the perfect scene for a chrome product.

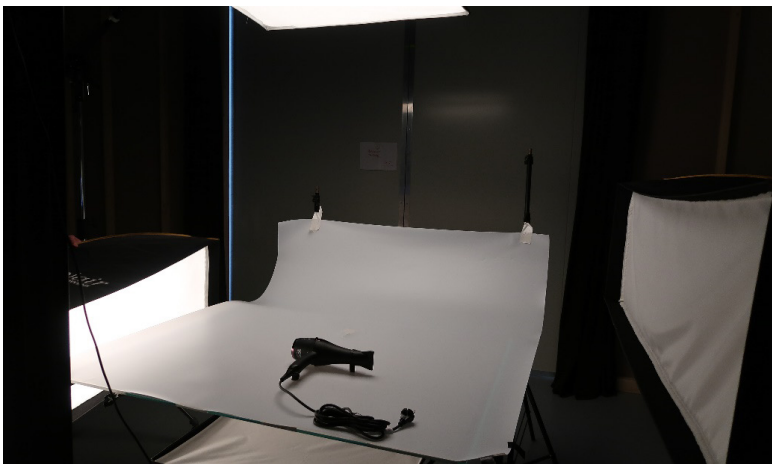


Figure 86, Studio set-up

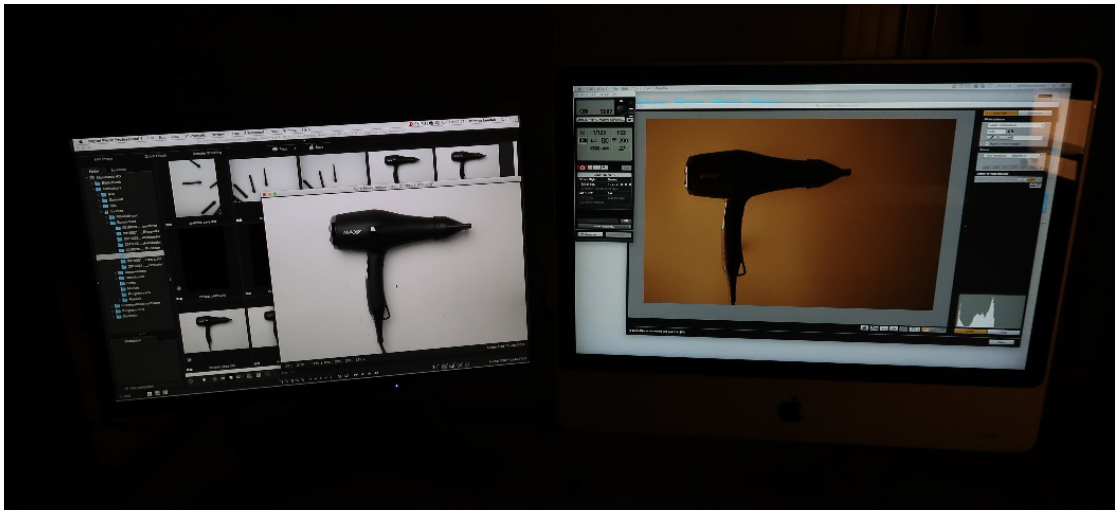


Figure 87, Left: final photo, Right: What can be seen on the camera

APPENDIX C - INTERVIEW NATURE PHOTOGRAPHER BIRGITTE BERGMAN

Birgitte is a nature photographer for several years. Her main focus is macrophotography. For this research it is interesting to learn from her about working with uncontrollable light sources and thinking creatively about the composition as it is. The interview is done in Dutch. Her answers are translated in English.

Biography

"Ik vond het altijd heerlijk om met fotografie bezig te zijn in de vakantie. Daarbij was zoom.nl een plek waar ik gemotiveerd werd en door alle reacties en tips die ik daar kreeg kon ik veel leren en mijn foto's verbeteren. Nadat ik een macrolens had gekocht werd ik geïnspireerd door de mogelijkheden van de kleine dingen in de natuur. Deze wilde ik vastleggen en de wereld laten zien hoe mooi de natuur is wanneer je de tijd neemt om ernaar te kijken. Ik heb nooit echt workshops gevolgd. Daarbij benader ik fotografie vaak ook niet vanuit een technische hoek, maar probeer ik vooral veel dingen uit tot ik het gewenste resultaat krijg."

"I loved to do photography during holidays. I become motivated by zoom.nl where I received a lot of comments and tips on my photo. From this, I learned a lot and improved my photographing skills.
When I brought my macro lens I was inspired by the possibilities and the small things of nature. I wanted to capture this and show how beautiful natures small world is when you just take some time to look at it.
I never went to any kind of workshop. I don't use a lot of technical features. While experimenting I mostly get the desired result."

Composition

"Vaak wanneer ik door de natuur loop, kijk ik of ik iets zie wat mij aanspreekt. Door veel verschillende foto's maken kan ik later kijken wat het beste voelt. Ik ben niet bewust bezig met wat voor compositie het beste bij een bepaalde setting past, maar het is vooral een gevoel ervoor krijgen wat wel en niet fijn kijkt. Het is denk ik ook heel persoonlijk kan zijn wat ieder in dat geval 'goed' vind.
Wanneer ik met een macrolens werk kunnen kleine bewegingen met de camera heel veel veranderen aan de setting. Zo kan opeens de belichting veel beter uitvallen als je een centimeter omhoog gaat met je camera, of wordt de compositie volledig anders wat veel meer een verhaal brengt.
Ik verander vaak ook bijna niets aan de natuursetting zoals het is. Soms haal ik wel eens een takje weg of wat blaadjes die het iets te druk maken, maar meer dan dat niet."

"When walking through nature, I'm looking around to find something that is appealing to me. By making different photos, I later can choose which one feels best. I'm not focussed on what composition works best for what setting. It more a personal preference, so it can be different for every person what he/she thinks is a 'good' composition.
When working with a macro lens, small movements can give a big difference in the setting. In this way, the lighting can be much better when you move a centimeter upwards or the composition is completely different which give more story to the photo.
I mostly don't change the natural setting as it is. Sometimes I might remove a twig or some leaves to make the setting less busy, but that's all."

Lighting

"Ik ga vaak op een vroege ochtend of richting de avond fotograferen. 's Ochtends staat de zon laag en geeft het niet teveel fel licht af. Hierdoor worden de kleuren mooier en kan ik mooi werken met tegenlicht van de zon. Een ander voordeel van de vroege ochtenden is dat de vlinders vaak nog aan het opwarmen zijn van de nacht en hierdoor meer blijven zitten en dus beter te fotograferen zijn.
's Avonds wordt de kleur warmer en dieper wat het vaak ook mooi maakt om foto's te maken. Ook op dat moment van de dag is de zon laag wat goed werkt voor de foto's.

Naast het zonlicht maak ik soms gebruik van een zaklampje, kerstlichtjes of reflectieschermen. Verder heb ik ook een flitsparaplu die in sommige gevallen handig is om te gebruiken en schaduwen creëer ik vaak door zelf in het zonlicht te gaan staan. Dat is gemakkelijk omdat de setting op een klein stukje gefocust is. Je kan hierdoor grappige

effecten maken waarbij bijvoorbeeld een krokus in een gecreëerde schaduw staat en de achtergrond in het zonnetje. Hierdoor is het licht in de achtergrond en meer gematigd licht in de voorgrond."

"I mostly photograph in the early morning or in the evening. In the morning, the sun is still low and doesn't give too much light. Because of this, the colours are more beautiful and I can nicely work with backlight. Another advantage of the early morning is that the butterflies still need to warm up from the night and don't fly away.
In the evening, the colours become warmer and deeper which is nice to photograph. Also, the same as in the morning the sun is low which is good for photographing.

Beside the sunlight, I sometimes use flashlights, Christmas lights or reflection screens. Furthermore, I have a flash umbrella which is useful in some cases, and often use my body to create shadows to stand in-between the sun and the setting. That's quite easy because the setting is focused on a small part. You also can create nice settings in which for example a crocus is standing in a created shadow and the background is in sunlight. Because of this, the light in the background is bright and in the foreground milder."

Colour and lighting

"Ik denk dat bij mij kleuren heel persoonlijk zijn. In mijn foto's zie ik vaak de pasteltinten terug. Roze, blauw en paars vind ik fijne tinten. Daarbij heb ik gemerkt dat rood en geel lastige kleuren zijn om vast te leggen. Ik weet niet precies waardoor dit komt, maar rood knalt heel vaak uit een foto waardoor het bijna fluoriderend lijkt. Het lijdt dan vaak af van het geheel. Daarom werk ik vaak niet met deze kleuren. De zachte kleuren die ik gebruik passen bij de zachte sfeer die ik vaak mooi vind om vast te leggen. Daarbij is dat wel persoonlijk. Ik zie ook veel fotografen die het heerlijk vinden om knalkleuren te werken."

"I think that the colours that I use are personal. In my pictures you mostly see pastel. Pink, blue and purple are colours that I like. Besides, I noticed that red and yellow are difficult colours to photograph. I don't know the exact reason, but they mostly pop up heavy till it almost looks fluorescent. This is distracting from the setting as a whole. That's why I don't work with these colours.
Soft colours also fit a soft ambiance which I love to capture. That's really something personal. I sometimes see photographers how love to work with the bright colours."

Explaining materials in photos

"Vooral in het ochtendlicht kan je veel gebruik maken van het strijklicht dat op de objecten valt. Hierdoor komt het beter tot zijn recht."

"Mostly in the morning light, you can use the floodlight on the objects. Through this, objects structure are visualized better."

After editing

"Zelf ben ik niet zo goed in werken met Photoshop en daardoor bewerk ik ook niet veel na in foto's. Met verschillende tools probeer ik een foto direct te schieten zoals ik het wil hebben. Het enige wat ik vaak nabewerk is de witbalans waarbij ik bijvoorbeeld een foto iets blauwer maak om de sfeer intenser te maken. Soms bewerk ik een blaadje uit het geheel omdat deze iets te aanwezig is en ik snij ook wel eens de foto een beetje bij om een betere compositie te maken. Ik heb nog nooit twee foto's gecombineerd ofzo. Dat zie ik wel vaak bij andere fotografen gebeuren wat gave effecten creëert, maar ik vind het juist mooi om terplekke een mooie setting te maken en voel niet de behoeft om me meer in fotoshop te gaan verdiepen. Ik vind het nabewerken ook niet het leukste van het fotograferen dus ik zal hier ook niet veel meer mee gaan doen."

"I'm not good in working with Photoshop and therefore I don't do a lot of after editing. With different tools, I try to make the picture directly as I prefer. The only thing that I do with after editing is the white balance, at which I make the picture, for example, a bit bluer to make the ambiance more intense. Sometimes I remove a leave from the setting because it is distracting and sometimes I crop the image a bit to get a better composition. I have never combined to pictures. I see other

photographers doing this often. They create nice effects with it, but still, I like to make the setting right at that moment. I don't feel the need for gaining more information about Photoshop. Besides, I don't like after editing so I will not do more with it."

General

"Over het algemeen gebruik ik nooit een statief. Ik vind het belemmerend in mijn bewegingen tijdens het fotograferen. Ik steun vaak op iets. Daarbij was het me ook opgevallen dat doordat ik door de zoeker kijk ik meer scherpe foto's maak dan mijn collega's die op een schermpje kijken. Ik denk dat dat komt doordat ik de camera tegen mijn hoofd houd en dit bepaalde bewegingen stabiliseert.
Verder is het me ook opgevallen dat foto's op mijn computerscherm er soms vele malen beter uitzien dan foto's op mijn camerascherm of andersom. Het is ongelofelijk wat voor een verschil het maakt op wat voor formaat je de scene bekijkt.
Wanneer ik met een setting bezig ben kan ik daar zo een half uur tot een uur foto's van maken. Op een goede dag maak ik gerust 200-300 foto's."

"Normally I never use a tripod. I think it obstructs me from moving around while photographing. Often I lean on something.
I also noticed that my pictures are sharper than my colleagues because I probably use the object-finder of the camera and keep the camera to my head. I prevent a lot of moving.
I also noticed that the picture on my laptop looks much better than on my camera and vice versa. It is incredible what the difference is of seeing the photo in different sizes.
When I working on a setting, it can take around half an hour till one hour to take pictures of it. On a good day, I usually make 200-300 photos."

After the interview, Birgitte showed some of her pictures. It was very inspiring how she worked with settings inside and outside. Besides, she is really creative in finding solutions for creating a setting.

Studio setting

Nature setting

Nature setting with Christmaslights in the background.

Flowers in the shadow and background light

Figure 88, Photos of Birgitte

APPENDIX D - ARDUINO AND PROCESSING CODES

The hardware of Arduino is shown in Figure 89. An external source is used to power the LEDs. A line of LEDs is placed in a ring around the dome. The five rings indicated five levels. The rings are placed in separate imports to control the rings individually.
Next, the complete sketch of Arduino and Processing is shown.

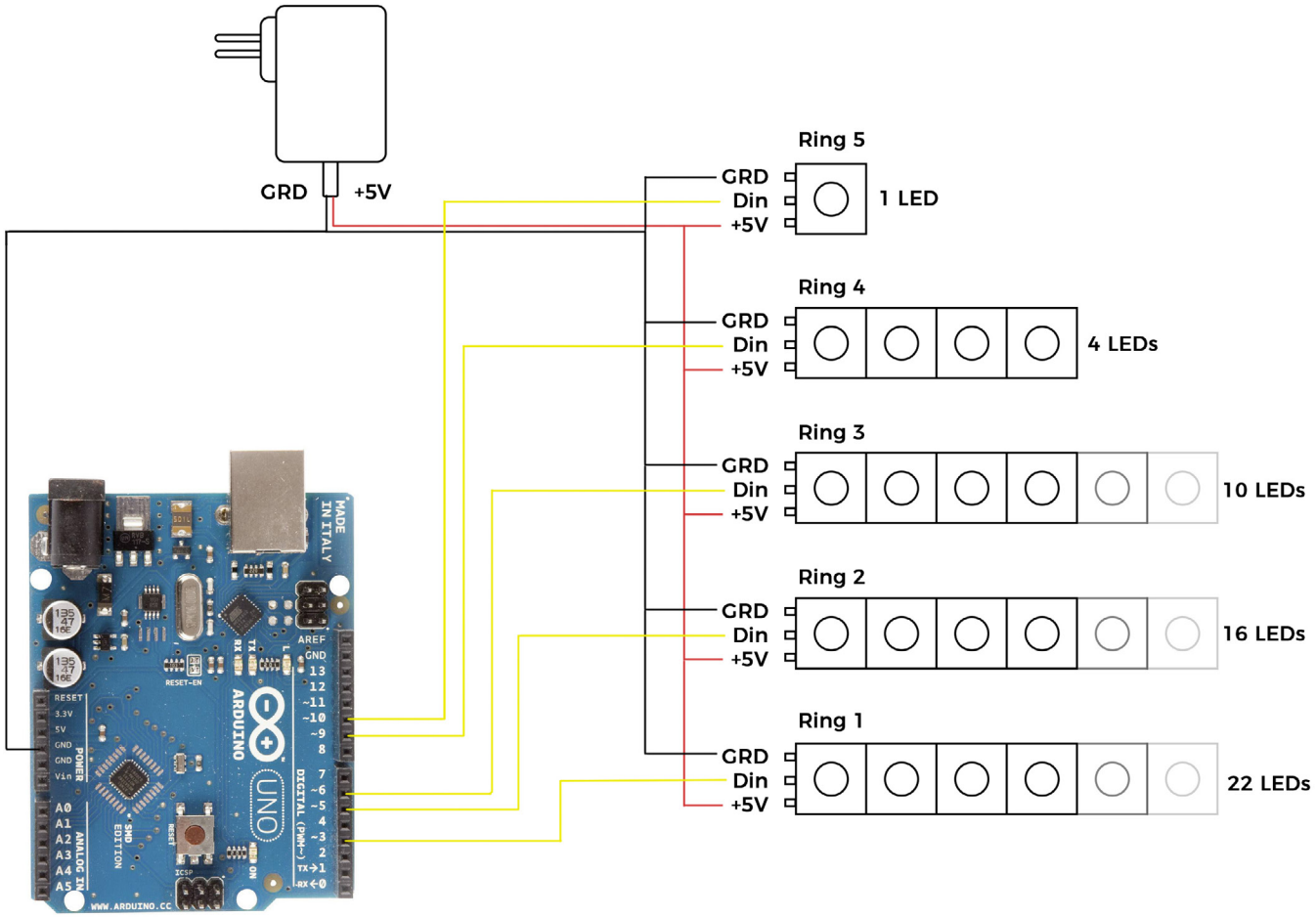


Figure 89, Hardware conncetion of Arduino and LEDs

Arduino code

```
#include <Adafruit_NeoPixel.h>
#ifdef __AVR__
#include <avr/power.h>
#endif

#define PIN1            3
#define PIN2            5
#define PIN3            6
#define PIN4            9
#define PIN5            10

#define NUMPIXELS1      25
#define NUMPIXELS2      17
#define NUMPIXELS3      11
#define NUMPIXELS4      5
#define NUMPIXELS5      1


int selected_led1 = 0;            // 360 degrees selected led within a ring
int selected_ring1 = 0;           // ring from bottom to top
int selected_led2 = 0;            // 360 degrees selected led within a ring
int selected_ring2 = 0;           // ring from bottom to top
int leds_per_ring = 0;            // amount of led per ring
int intensity_led1 = 0;           // intensity per led
int intensity_led2 = 0;           // intensity per led

boolean diffuse = false;

//int last_led_position = 0;
//int last_ring_position = 0;

Adafruit_NeoPixel pixels1 = Adafruit_NeoPixel(NUMPIXELS1, PIN1, NEO_GRB + NEO_KHZ800);
Adafruit_NeoPixel pixels2 = Adafruit_NeoPixel(NUMPIXELS2, PIN2, NEO_GRB + NEO_KHZ800);
Adafruit_NeoPixel pixels3 = Adafruit_NeoPixel(NUMPIXELS3, PIN3, NEO_GRB + NEO_KHZ800);
Adafruit_NeoPixel pixels4 = Adafruit_NeoPixel(NUMPIXELS4, PIN4, NEO_GRB + NEO_KHZ800);
Adafruit_NeoPixel pixels5 = Adafruit_NeoPixel(NUMPIXELS5, PIN5, NEO_GRB + NEO_KHZ800);

void setup() {
  pinMode (PIN1, OUTPUT);
  pinMode (PIN2, OUTPUT);
  pinMode (PIN3, OUTPUT);
  pinMode (PIN4, OUTPUT);
  pinMode (PIN5, OUTPUT);
  Serial.begin(9600);
  pixels1.begin();
  pixels2.begin();
  pixels3.begin();
  pixels4.begin();
  pixels5.begin();
}

void loop() {

  //Turn off all rings all leds
  if (diffuse == false) {
    set_color(0, pixels1.Color(0, 0, 0), 1, 1);
    set_color(0, pixels2.Color(0, 0, 0), 2, 1);
    set_color(0, pixels3.Color(0, 0, 0), 3, 1);
    set_color(0, pixels4.Color(0, 0, 0), 4, 1);
    set_color(0, pixels5.Color(0, 0, 0), 5, 1);

    //defining which led need to be on. Two switches for two separated leds to be on and 5 cases for the five rings.
    switch (selected_ring1) {
      case 1:
        leds_per_ring = 25;
        set_color(selected_led1, pixels1.Color(intensity_led1, intensity_led1, intensity_led1), selected_ring1, 0);
        break;

      case 2:
        leds_per_ring = 17;
        set_color(selected_led1, pixels2.Color(intensity_led1, intensity_led1, intensity_led1), selected_ring1, 0);
        break;

      case 3:
        leds_per_ring = 11;
        set_color(selected_led1, pixels3.Color(intensity_led1, intensity_led1, intensity_led1), selected_ring1, 0);
        break;

      case 4:
        leds_per_ring = 5;
        set_color(selected_led1, pixels4.Color(intensity_led1, intensity_led1, intensity_led1), selected_ring1, 0);
        break;
```

```
      case 5:
        leds_per_ring = 1;
        set_color(selected_led1, pixels5.Color(intensity_led1, intensity_led1, intensity_led1), selected_ring1, 0);
        break;
    }

    switch (selected_ring2) {
      case 1:
        leds_per_ring = 25;
        set_color(selected_led2, pixels1.Color(intensity_led2, intensity_led2, intensity_led2), selected_ring2, 0);
        break;

      case 2:
        leds_per_ring = 17;
        set_color(selected_led2, pixels2.Color(intensity_led2, intensity_led2, intensity_led2), selected_ring2, 0);
        break;

      case 3:
        leds_per_ring = 11;
        set_color(selected_led2, pixels3.Color(intensity_led2, intensity_led2, intensity_led2), selected_ring2, 0);
        break;

      case 4:
        leds_per_ring = 5;
        set_color(selected_led2, pixels4.Color(intensity_led2, intensity_led2, intensity_led2), selected_ring2, 0);
        break;

      case 5:
        leds_per_ring = 1;
        set_color(selected_led2, pixels5.Color(intensity_led2, intensity_led2, intensity_led2), selected_ring2, 0);
        break;
    }
    // when no input for one led ON is given, diffuse light will be activated.
  } else {
    set_color(0, pixels1.Color(50, 50, 50), 1, 0);
    set_color(0, pixels2.Color(50, 50, 50), 2, 0);
    set_color(0, pixels3.Color(50, 50, 50), 3, 0);
    set_color(0, pixels4.Color(50, 50, 50), 4, 0);
    set_color(0, pixels5.Color(50, 50, 50), 5, 0);
  }

  pixels1.show();
  pixels2.show();
  pixels3.show();
  pixels4.show();
  pixels5.show();
}

void set_color(int pixelnumber, uint32_t color, int ring, bool alloff)
{
  switch (ring) {
    case 1:
      // statements
      for (int i = 0; i < 25; ++i) {
        if (i == pixelnumber) {
          pixels1.setPixelColor(i, color);
        }
        else if (alloff) {
          pixels1.setPixelColor(i, pixels1.Color(0, 0, 0));
        } else if (diffuse) {
          pixels1.setPixelColor(i, color);

        }
      }
      break;

    case 2:
      // statements
      for (int i = 0; i < 17; ++i) {
        if (i == pixelnumber) {
          pixels2.setPixelColor(i, color);
        }
        else if (alloff) {
          pixels2.setPixelColor(i, pixels2.Color(0, 0, 0));
        } else if (diffuse) {
          pixels2.setPixelColor(i, color);
        }
      }
      break;

    case 3:
      // statements
      for (int i = 0; i < 11; ++i) {
```

```
        if (i == pixelnumber) {
          pixels3.setPixelColor(i, color);
        }
        else if (alloff) {
          pixels3.setPixelColor(i, pixels3.Color(0, 0, 0));
        } else if (diffuse) {
          pixels3.setPixelColor(i, color);
        }
      }
      break;

    case 4:
      // statements
      for (int i = 0; i < 5; ++i) {
        if (i == pixelnumber) {
          pixels4.setPixelColor(i, color);
        }
        else if (alloff) {
          pixels4.setPixelColor(i, pixels4.Color(0, 0, 0));
        } else if (diffuse) {
          pixels4.setPixelColor(i, color);
        }
      }
      break;

    case 5:
      // statements
      for (int i = 0; i < 1; ++i) {
        if (i == pixelnumber) {
          pixels5.setPixelColor(i, color);
        }
        else if (alloff) {
          pixels5.setPixelColor(i, pixels5.Color(0, 0, 0));
        } else if (diffuse) {
          pixels5.setPixelColor(i, color);
        }
      }
      break;
  }
}

// receiving data from processing and use it in the code above.
void serialEvent() {
  while (Serial.available() > 0) {
    int value  = Serial.parseInt();
    char cc =  Serial.read();
    if (cc == 'a') {
      selected_led1 = map(value, 0, 360, 0, leds_per_ring - 1);
    }
    if (cc == 'b') {
      selected_ring1 = value;
    }
    if (cc == 'c') {
      selected_led2 = map(value, 0, 360, 0, leds_per_ring - 1);
    }
    if (cc == 'd') {
      selected_ring2 = value;
    }
    if (cc == 'e') {
      diffuse = value;
    }
    if (cc == 'f') {
      intensity_led1 = value;
    }
    if (cc == 'g') {
      intensity_led2 = value;
    }
  }
}
```

Processing code

```
import controlP5.*;
import processing.serial.*;

Serial myPort;
ControlP5 cp5a;
ControlP5 cp5b;
ControlP5 cp5c;

int selected_led1 = 0;
int selected_ring1 = 0;
int selected_led2 = 0;
int selected_ring2 = 0;

int value1 = 0;
int value2 = 0;

void setup() {
  size(400, 1000);
  myPort = new Serial(this, "COM7", 9600);
  noStroke();

  cp5a = new ControlP5(this);
  cp5b = new ControlP5(this);
  cp5c = new ControlP5(this);


  cp5a.addSlider("selected_led1")
    .setPosition(130, 210)
    .setRange(0, 360)
    .setSize(200, 35)
    .setNumberOfTickMarks(25)
    .setSliderMode(Slider.FLEXIBLE)
    .setValue(0)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5a.addSlider("intensity_led1")
    .setPosition(130, 330)
    .setRange(0, 255)
    .setSize(200, 35)
    .setValue(255)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5b.addSlider("selected_ring1")
    .setPosition(50, 200)
    .setRange(1, 5)
    .setSize(35, 200)
    .setNumberOfTickMarks(5)
    .setSliderMode(Slider.FLEXIBLE)
    .setValue(0)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5a.addSlider("selected_led2")
    .setPosition(130, 510)
```

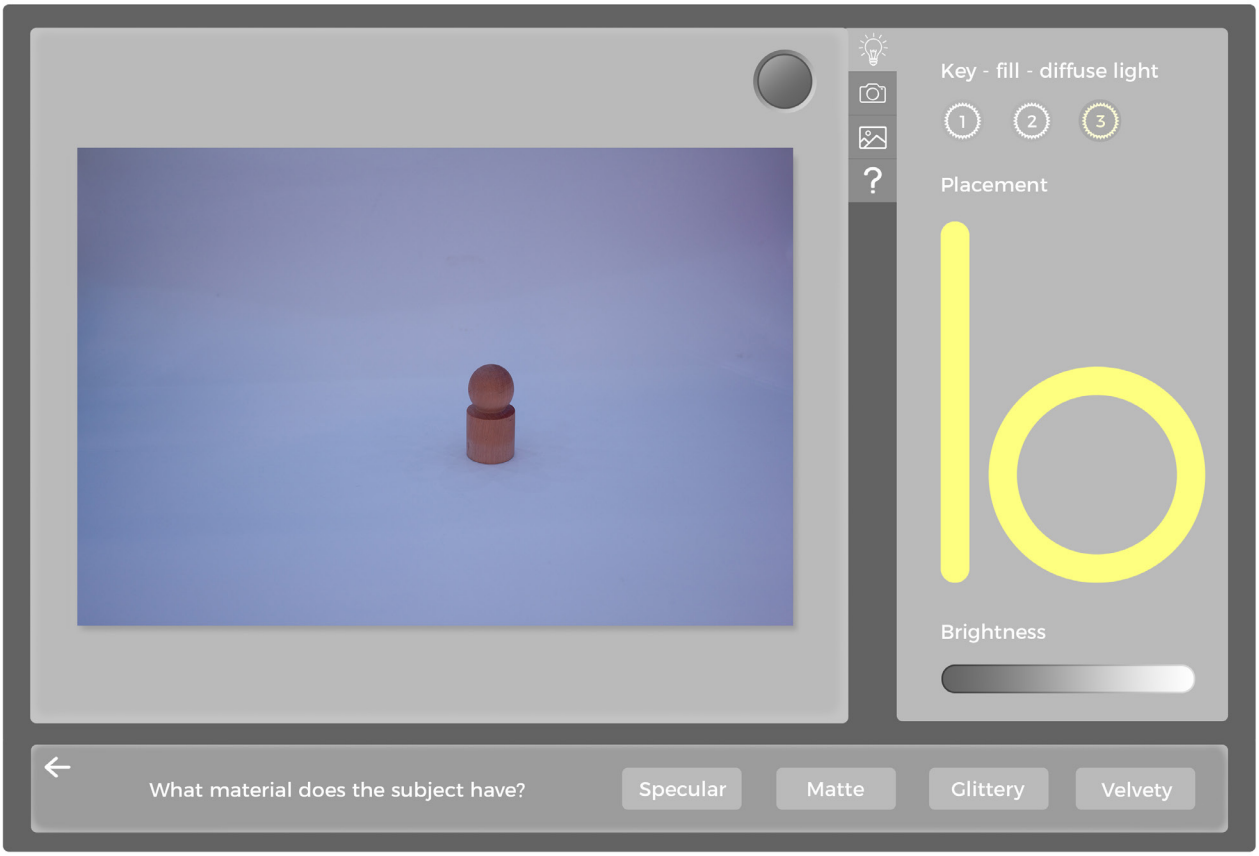
```
    .setRange(0, 360)
    .setSize(200, 35)
    .setNumberOfTickMarks(23)
    .setSliderMode(Slider.FLEXIBLE)
    .setValue(0)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5a.addSlider("intensity_led2")
    .setPosition(130, 630)
    .setRange(0, 255)
    .setSize(200, 35)
    .setValue(255)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5b.addSlider("selected_ring2")
    .setPosition(50, 500)
    .setRange(1, 5)
    .setSize(35, 200)
    .setNumberOfTickMarks(5)
    .setSliderMode(Slider.FLEXIBLE)
    .setValue(0)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));

  cp5c.addToggle("diffuse")
    .setValue(false)
    .setPosition(200, 55)
    .setSize(40, 40)
    .setColorForeground(color(255, 255, 130))
    .setColorBackground(color(255, 255, 225))
    .setColorActive(color(255, 255, 110))
    .setColorValue(color(255, 255, 255));
}

void draw() {
  background(185, 186, 187);

  textSize(20);
  fill(255, 255, 255);
  text("Key light", 50, 180);


  textSize(20);
  fill(255, 255, 255);
  text("Fill light", 50, 480);


  textSize(20);
  fill(255, 255, 255);
  text("Diffuse light", 50, 80);
}

void controlEvent(ControlEvent theEvent) {
  if (theEvent.isController()) {
```

```
    print("control event from : "+theEvent.getController().getName());
    println(", value : "+theEvent.getController().getValue());

    if (theEvent.getController().getName() == "selected_led1") {
      int val1 = int(theEvent.getController().getValue());
      myPort.write("a" + val1);
    }

    if (theEvent.getController().getName()== "selected_ring1") {
      int val2 = int(theEvent.getController().getValue());
      myPort.write("b" + val2);
    }
    if (theEvent.getController().getName() == "selected_led2") {
      int val1 = int(theEvent.getController().getValue());
      myPort.write("c" + val1);
    }

    if (theEvent.getController().getName()== "selected_ring2") {
      int val2 = int(theEvent.getController().getValue());
      myPort.write("d" + val2);
    }
    if (theEvent.getController().getName()== "diffuse") {
      int val3 = int(theEvent.getController().getValue());
      myPort.write("e" + val3);
      myPort.write("e" + val3);
    }
    if (theEvent.getController().getName()== "intensity_led1") {
      int val4 = int(theEvent.getController().getValue());
      myPort.write("f" + val4);
    }
    if (theEvent.getController().getName()== "intensity_led2") {
      int val5 = int(theEvent.getController().getValue());
      myPort.write("g" + val5);
    }
  }
}
```

APPENDIX E - FIRST INTERFACE

By opening the link it is possible to see all screens of the interface. An invisible button is created on the top left to go back to the first page.

https://xd.adobe.com/view/f4ff5938-cb68-4bbe-8caf-f3e8b3adf628



APPENDIX F - USER TEST PROCEDURE

Welcome and thank you for participating in this user research. This concept is developed for students to shoot professional photos of the products they have made.
On the left, you see the interface of the concept. You will firstly interact with this and then be guided towards the laptop for other interactions.
On the right, you see the light studio. You have made a product, and as you can see it is already placed in the middle of the scene.
You want the product in focus and to change the light in order to receive the most communicative image.

Participant 1
What is age, degree, io student?

>> Scale form
The product
Matte – Spherical shape – yes texture – no colour

You can use the interface. >> Observation sheet

- What light would you use with this product?
  key-light fill-light diffuse no answer
- How would you place the light to explain the texture well?
  High Low striking surface

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings

- In a situation of a moving object, what setting would you use?
  Tv shutter speed regulation

You can go to photo editing. >> Observation sheet

>> Scale form
>> Interview

Participant 2
What is age, degree, io student?

>> Scale form
The product
Matte – Spherical shape – no texture – yes colour

You can use the interface. >> Observation sheet
- What light would you use with this product?
  key-light fill-light diffuse no answer
- Is there another way of explaining the colour well?
  Decreasing contrast with fill-light soft box

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings
- In a situation of a moving object, what setting would you use?
  Tv shutter speed regulation

You can go to photo editing. >> Observation sheet

>> Scale form
>> Interview

Participant 3
What is age, degree, io student?

>> Scale form
The product
Glossy– Cube – hard reflection – no colour

You can use the interface. >> Observation sheet
- What light would you use with this product?
  key-light fill-light diffuse no answer

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings
- If you want one specific part in focus and not the background. What setting can you use?
  Av aperture regulation

You can go to photo editing. >> Observation sheet

>> Scale form
>> Interview

Participant 4
What is age, degree, io student?

>> Scale form
The product
Glossy– Cube – soft reflection – no colour

You can use the interface. >> Observation sheet
- What light would you use with this product?
  key-light fill-light diffuse no answer

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings
- If you want one specific part in focus and not the background. What setting can you use?
  Av aperture regulation

You can go to photo editing. >> Observation sheet

>> Scale form
>> Interview

Participant 5
What is age, degree, io student?

>> Scale form
The product
Matte – Cylinder – yes texture– yes colour

You can use the interface. >> Observation sheet
- What light would you use with this product?
  key-light fill-light diffuse no answer
- Is there another way of explaining the colour well?
  Decreasing contrast with fill-light soft box

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings
- In a situation of a moving object, what setting would you use?
  Tv shutter speed regulation

You can go to photo editing. >> Observation sheet

>> Scale form
>> Interview

Participant 6

What is age, degree, io student?

>> Scale form

The product

Gloss – Cylinder – yes reflection – yes colour

You can use the interface. >> Observation sheet

- What light would you use with this product?
  key-light fill-light diffuse no answer
- Is there another way of explaining the colour well?
  Decreasing contrast with fill-light soft box

Interaction with the sliders on the computer >> Observation sheet

You can go to the camera settings

- If you want one specific part in focus and not the background. What setting can you use?
  Av aperture regulation

You can go to photo editing. >> Observation sheet

>> Scale form

>> Interview

APPENDIX G - CONCENT FORM

Consent for Participation in User Test

Dear participant,

Within the context of the graduation course, which is coordinated by S. Pont and J. Kuiper from Delft University of Technology, Faculty of Industrial Design Engineering, we are conducting a research about improving the concept of the light studio. The aim of the study is to discover product related problems which affects users' experiences and their interactions.

User Test Information

The user test will be held on the 12th of June 2019. The schedule of the study is going to be appointed in advance. As a volunteer participant, you are expected to be informed of your Participant Rights and Use of Data.

Participant Rights and Use of Data

1. Your participation in this project is voluntary and you will not be paid for your contribution. You may withdraw and discontinue participation during the test at any time without penalty.

2. If you feel uncomfortable in any way during the task scenarios or interview session, you have the right to decline to continue to the task, to answer any question or to end the interview.

3. Participation involves being observed and interviewed by researchers from Delft University of Technology. The study will last approximately 30 minutes including task scenarios and interview/questionnaire. You are going to be recorded via audio during the study. Additionally, notes will be written during the interview. If you do not want to be recorded or/and taped, you are free for not participating in the study.

4. No personal identification information will be used in any reports using the data gathered from this study. Your answers will be kept strictly confidential and evaluated only by the researcher.

Participant 1

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☑ I have read the consent form and I agree to the terms and conditions in this consent form.

☑ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

Name Researcher: Mehdi

Date: 12-06-19

Signature Participant

Name Participant: Casper

Date: 12 6 19

Participant 2

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☒ I have read the consent form and I agree to the terms and conditions in this consent form.

☒ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

Name Researcher: Mehdi

Date: 12-6-19

Signature Participant

Name Participant: Carolijn Sluijter

Date: 12-6-19

Participant 3

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☑ I have read the consent form and I agree to the terms and conditions in this consent form.

☑ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

MJaaker

Name Researcher: Mehdi

Date: 12-06-19

Signature Participant

Visser

Name Participant: Eilwa Visser

Date: 12 06 19

Participant 4

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☑ I have read the consent form and I agree to the terms and conditions in this consent form.

☑ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

MJaaker

Name Researcher: Mehdi

Date: 13-06-19

Signature Participant

Jessica Tseng

Name Participant: Jessica Tseng

Date: 13-6-2019

Participant 5

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☑ I have read the consent form and I agree to the terms and conditions in this consent form.

☑ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

MJonker

Name Researcher: Mehdi

Date: 13-06-19

Signature Participant

Name Participant: Wies

Date: 13-06-2019

Participant 6

By agreeing this below, you certify that you have read this consent form and had all your questions answered for your satisfaction, you are aware of your rights as a participant listed above and you are accepting to participate the study voluntarily.

☒ I have read the consent form and I agree to the terms and conditions in this consent form.

☒ I give the researchers permission to use all data collected during the user test, including voice recordings.

Thank you for your contribution in advance!

Signature Researcher

MJonker

Name Researcher: Mehdi

Date: 13-06-19

Signature Participant

Name Participant: Suzanne Lamar

Date: 13/6/2019

APPENDIX H - LIKERT SCALE & OBSERVATION SHEETS

Participant 1

	Do not agree						Fully agree
Clarity of steps	0	0	0	0	0	0	0
Understandable	0	0	0	0	0	0	0
Receiving new knowledge	0	0	0	0	0	0	0
Confident while interacting	0	0	0	0	0	0	0
Enjoyable	0	0	0	0	0	0	0
Inspiring	0	0	0	0	0	0	0
In control	0	0	0	0	0	0	0

Participant 2

	Do not agree						Fully agree
Clarity of steps	0	0	0	0	0	0	0
Understandable	0	0	0	0	0	0	0
Receiving new knowledge	0	0	0	0	0	0	0
Confident while interacting	0	0	0	0	0	0	0
Enjoyable	0	0	0	0	0	0	0
Inspiring	0	0	0	0	0	0	0
In control	0	0	0	0	0	0	0

Participant 3

	Do not agree						Fully agree
Clarity of steps	0	0	0	0	0	0	0
Understandable	0	0	0	0	0	0	0
Receiving new knowledge	0	0	0	0	0	0	0
Confident while interacting	0	0	0	0	0	0	0
Enjoyable	0	0	0	0	0	0	0
Inspiring	0	0	0	0	0	0	0
In control	0	0	0	0	0	0	0

Participant 4

	Do not agree						Fully agree
Clarity of steps	0	0	0	0	0	0	0
Understandable	0	0	0	0	0	0	0
Receiving new knowledge	0	0	0	0	0	0	0
Confident while interacting	0	0	0	0	0	0	0
Enjoyable	0	0	0	0	0	0	0
Inspiring	0	0	0	0	0	0	0
In control	0	0	0	0	0	0	0

Participant 5

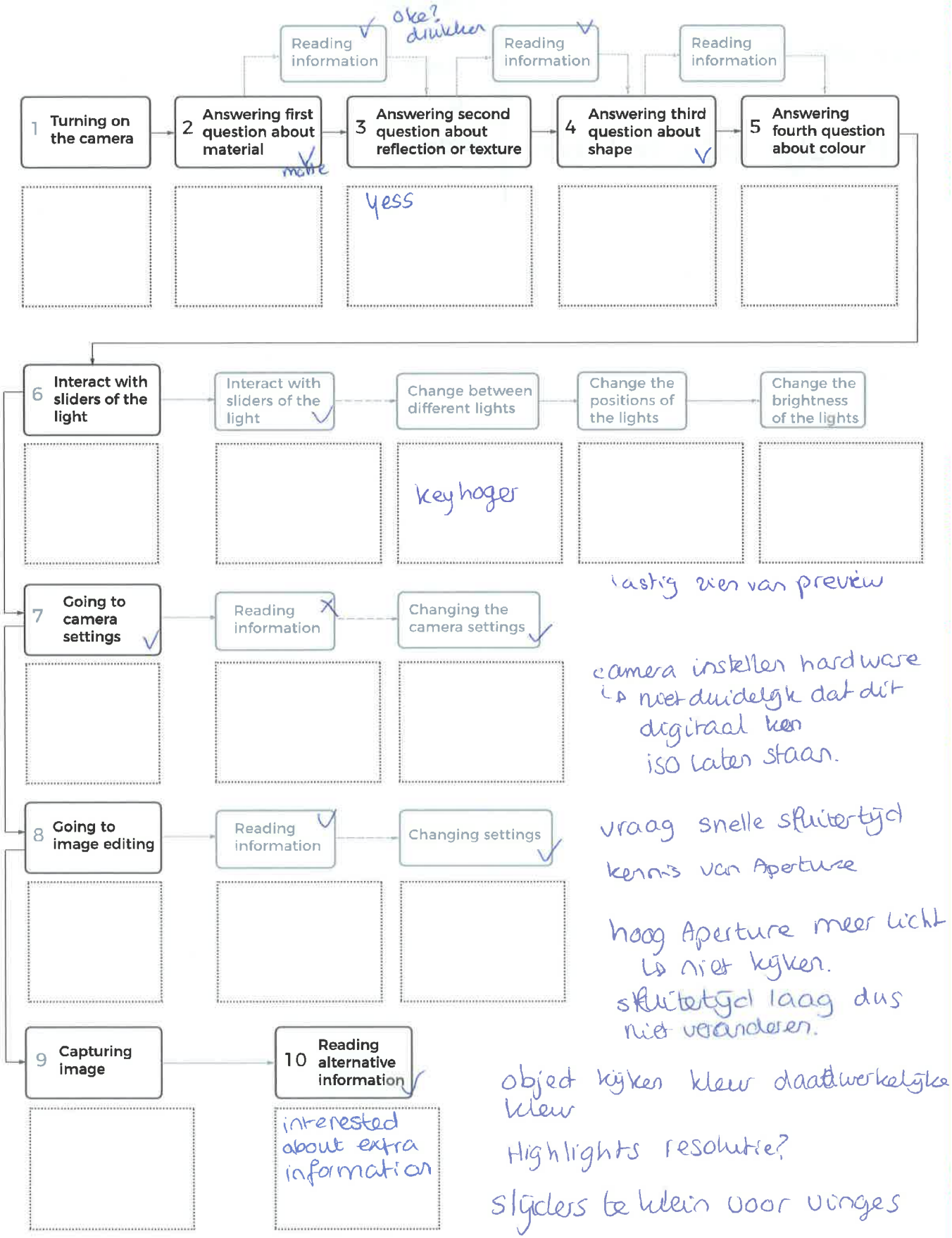
	Do not agree						Fully agree
Clarity of steps	0	0	0	0		0	0
Understandable	0	0	0	0		0	0
Receiving new knowledge	0	0	0	0	0		0
Confident while interacting	0	0	0		0	0	0
Enjoyable	0	0	0	0	0	0	
Inspiring	0	0	0	0	0		0
In control	0	0	0	0		0	0

Participant 6

	Do not agree						Fully agree
Clarity of steps	0	0	0	0		0	0
Understandable	0	0	0	0	0		0
Receiving new knowledge	0	0	0	0	0		0
Confident while interacting	0	0	0		0	0	0
Enjoyable	0	0	0	0	0		0
Inspiring	0	0	0	0	0		0
In control	0	0	0	0		0	0

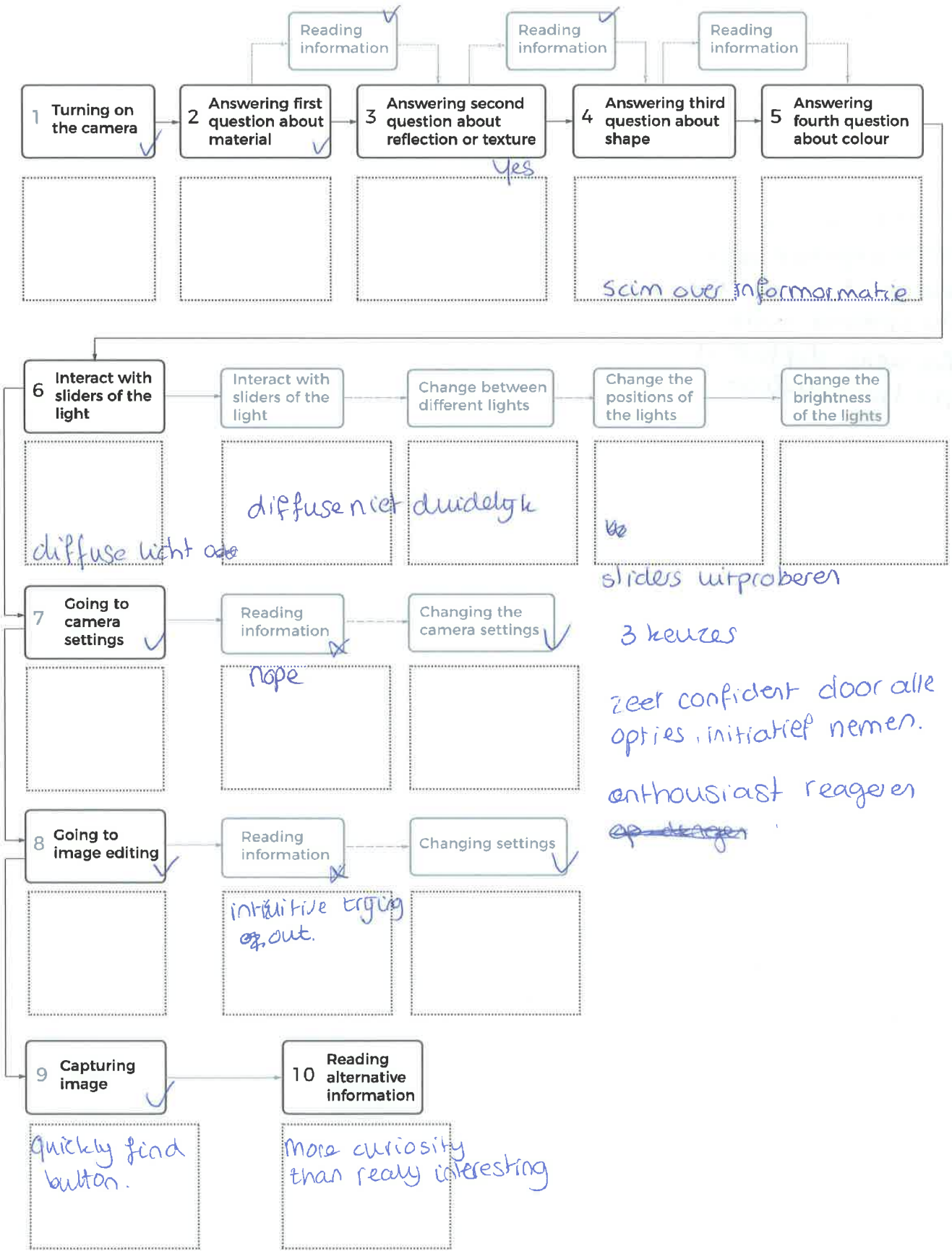
Participant 1

Obervation sheet



Participant 2

Obervation sheet



Participant 3

Obervation sheet

door ~~the~~ product into camer paandachtig

family of angles?

Reading information ✓

Reading information ✓

Reading information ✓

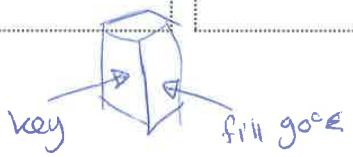
1 Turning on the camera → 2 Answering first question about material ✗ → 3 Answering second question about reflection or texture ✓ → 4 Answering third question about shape ✓ → 5 Answering fourth question about colour ✓

zoekende dacht eerst sliders te gebruiken

6 Interact with sliders of the light → Interact with sliders of the light → Change between different lights → Change the positions of the lights → Change the brightness of the lights

key-light & richting licht zelf bepalen

hoogte duidelijk



7 Going to camera settings ✓ → Reading information ✗ → Changing the camera settings

self placing the camera on manual, changing settings alles staat

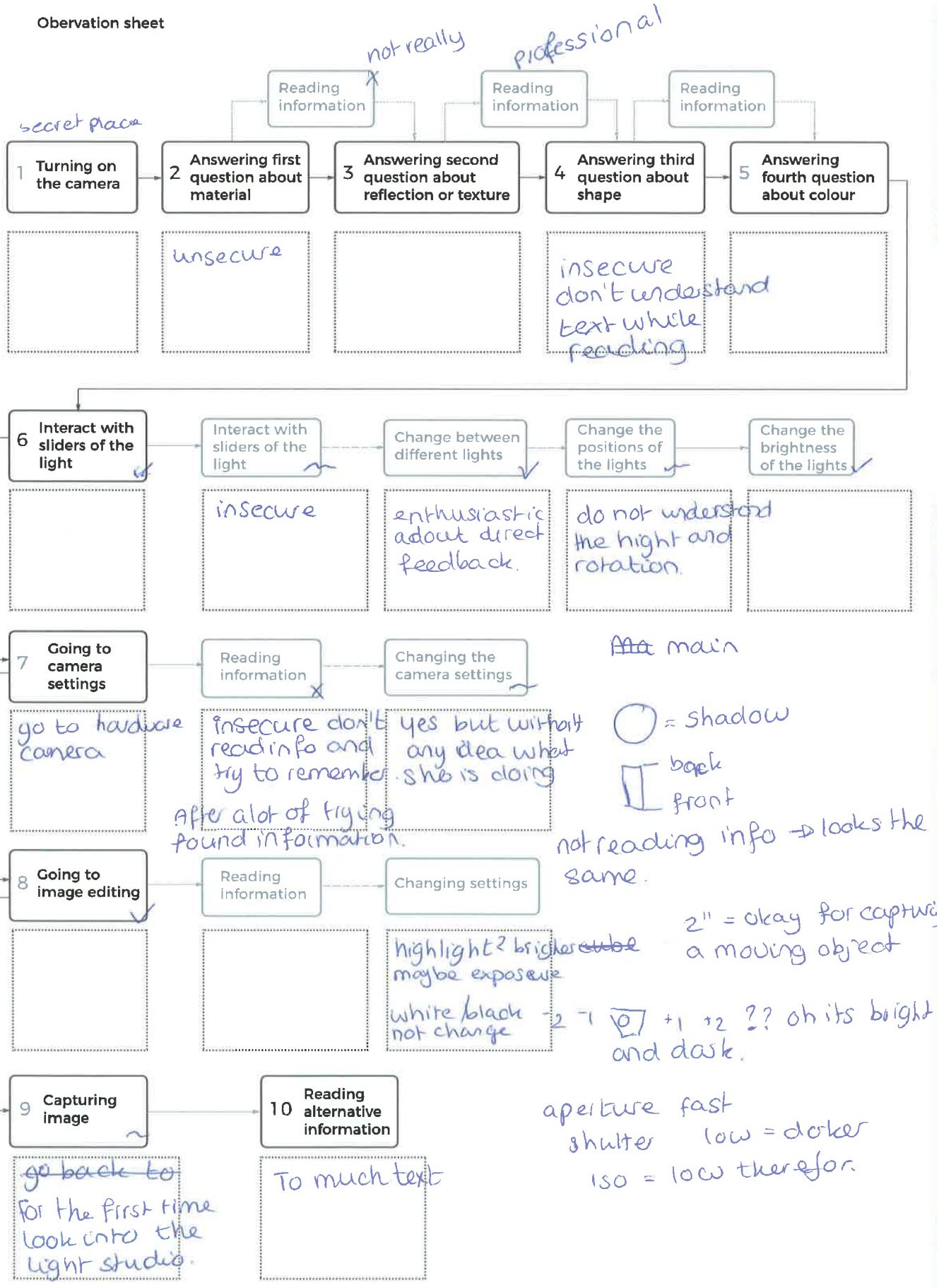
makkelijk ~~dan~~ switchen tussen interface en camera knoppen.

8 Going to image editing → Reading information ✗ → Changing settings

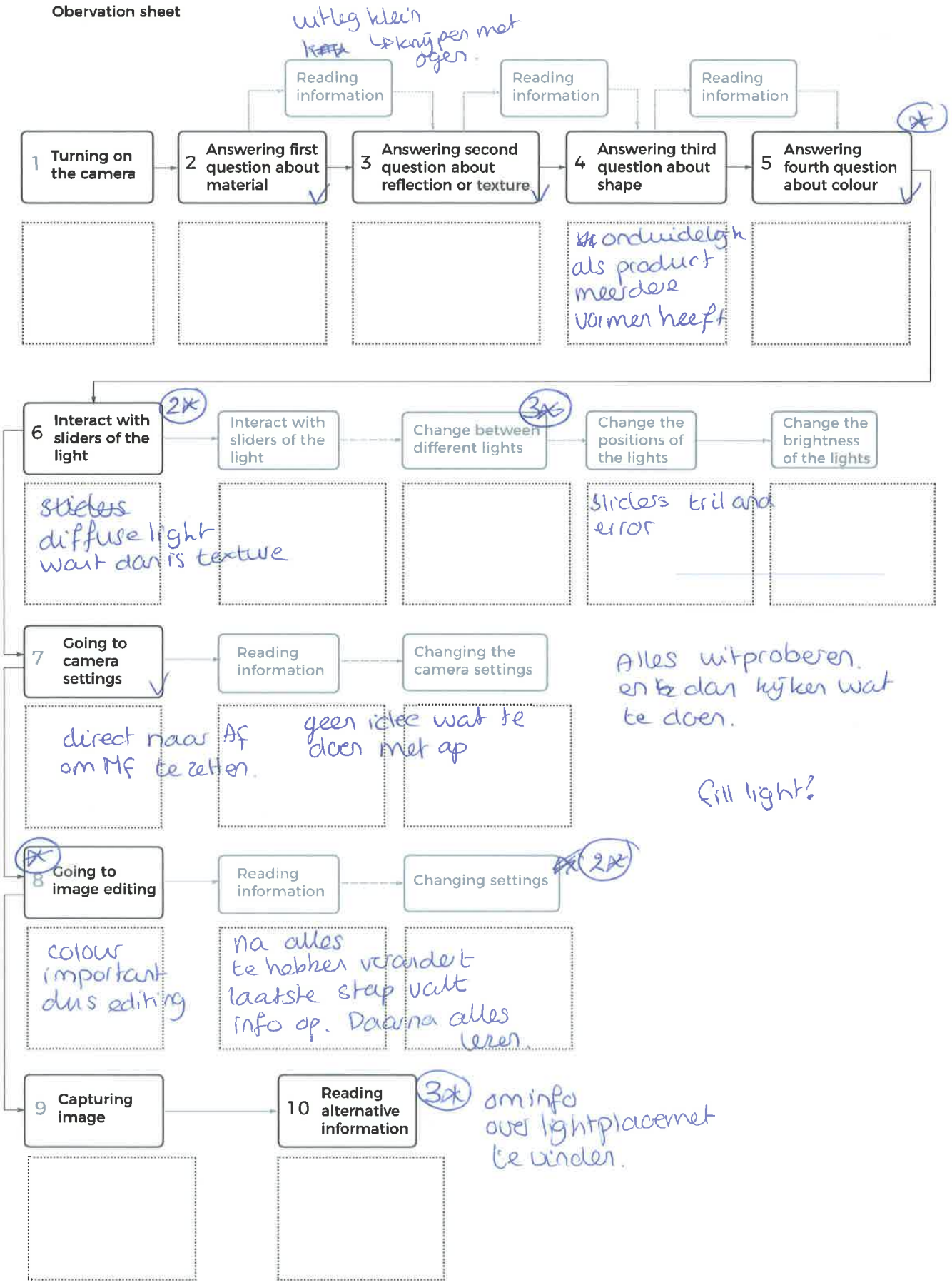
camera profile

9 Capturing image ✓ → 10 Reading alternative information

Participant 4

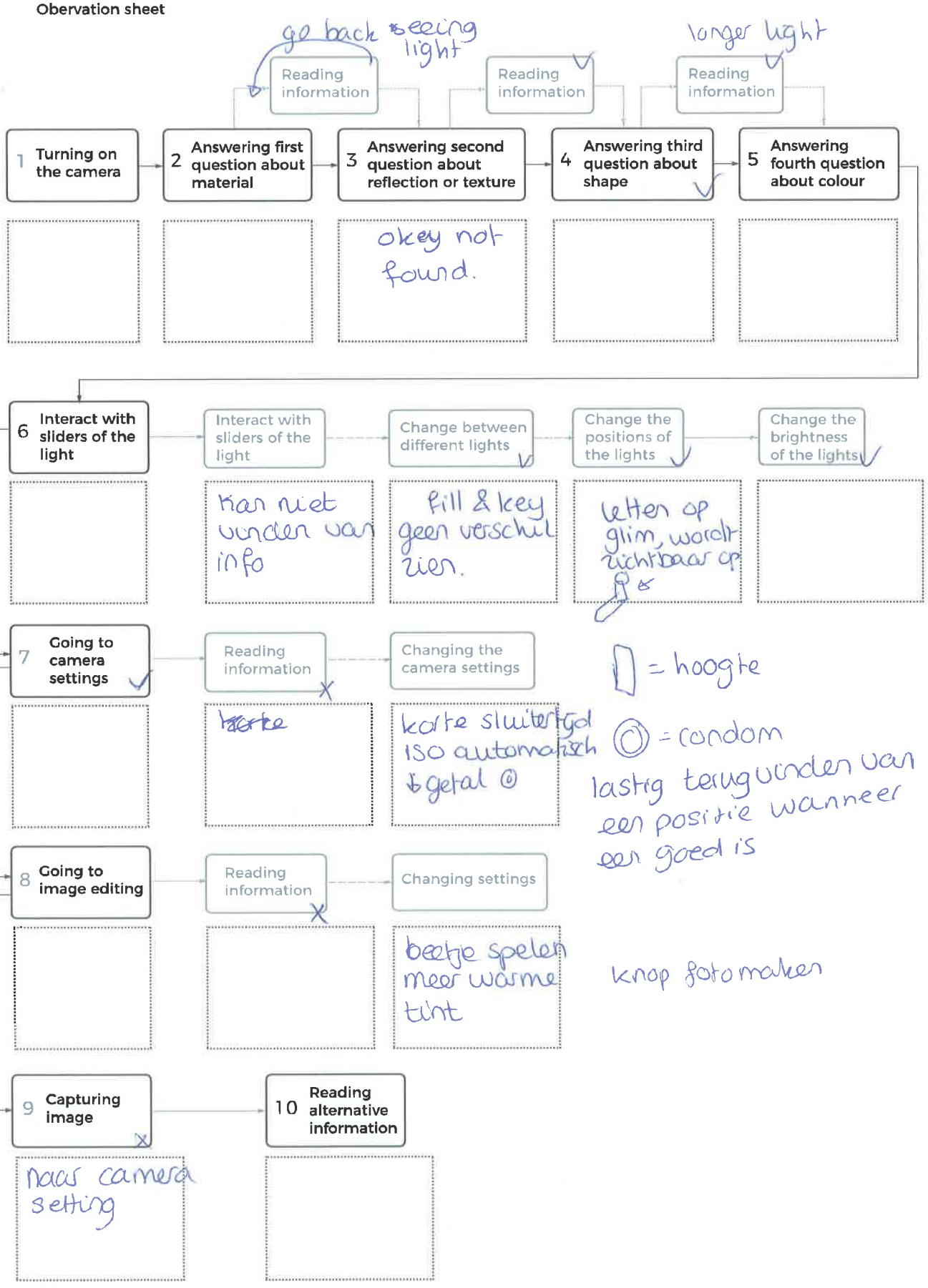


Participant 5



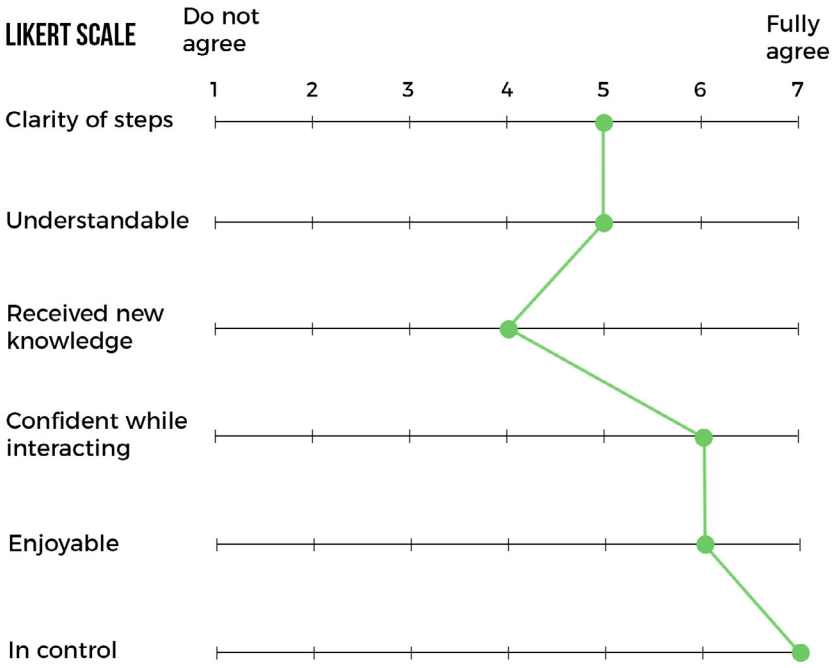
Participant 6

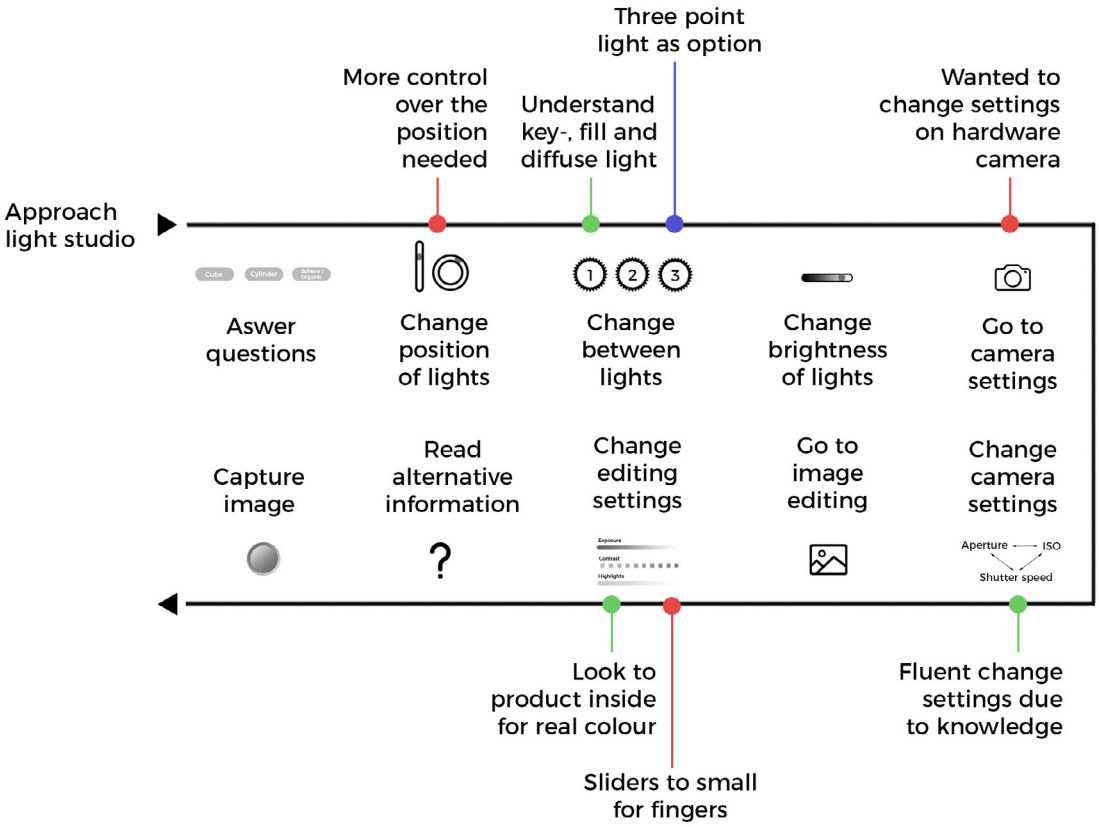
Obervation sheet



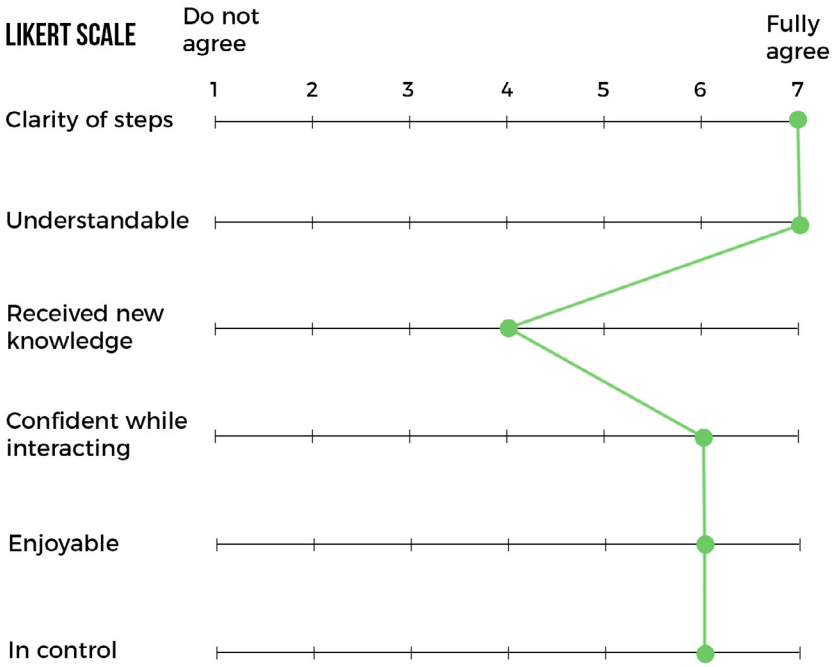
APPENDIX I - RESULTS PER PARTICIPANT

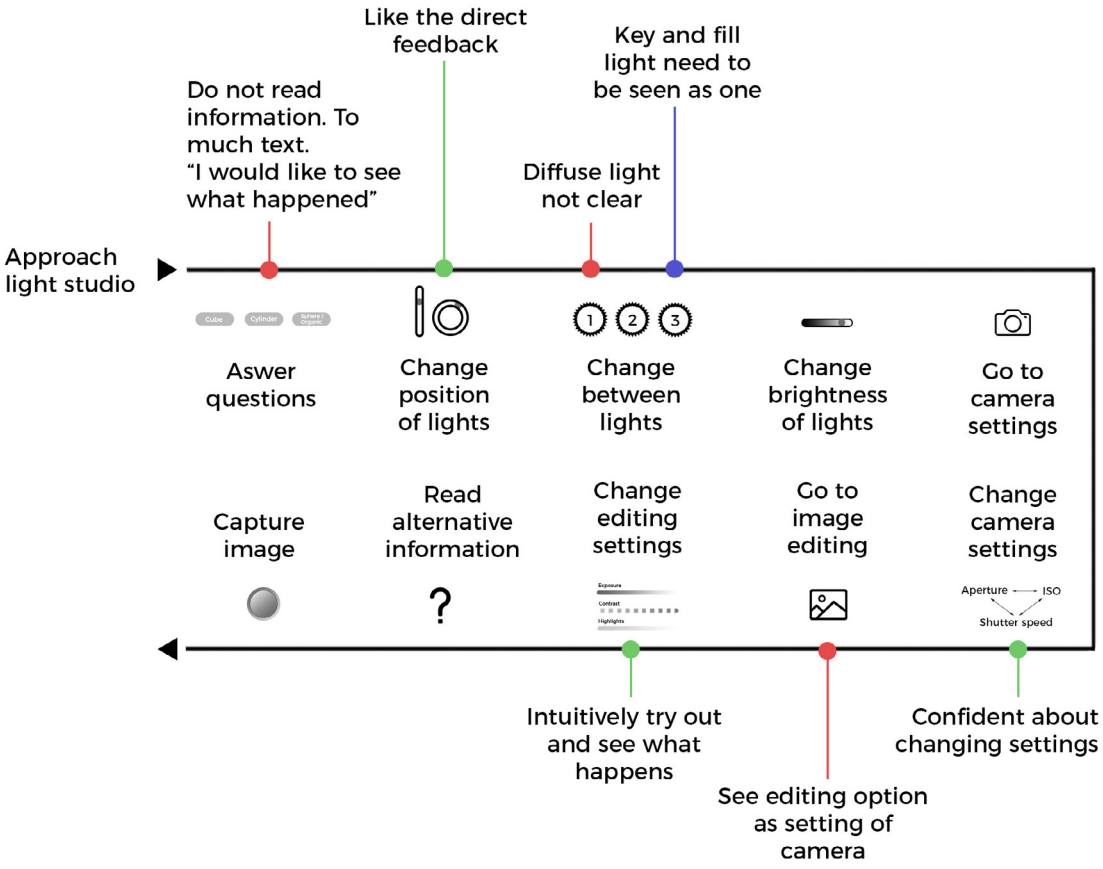
Participant 1
Participant 1 followed the course Video for Designers. In this course he learned about using a DSLR and different lights for the setting. Before the course he most often used his mobile phone for photography, but now after the course he uses the DSLR for making (product) photos.



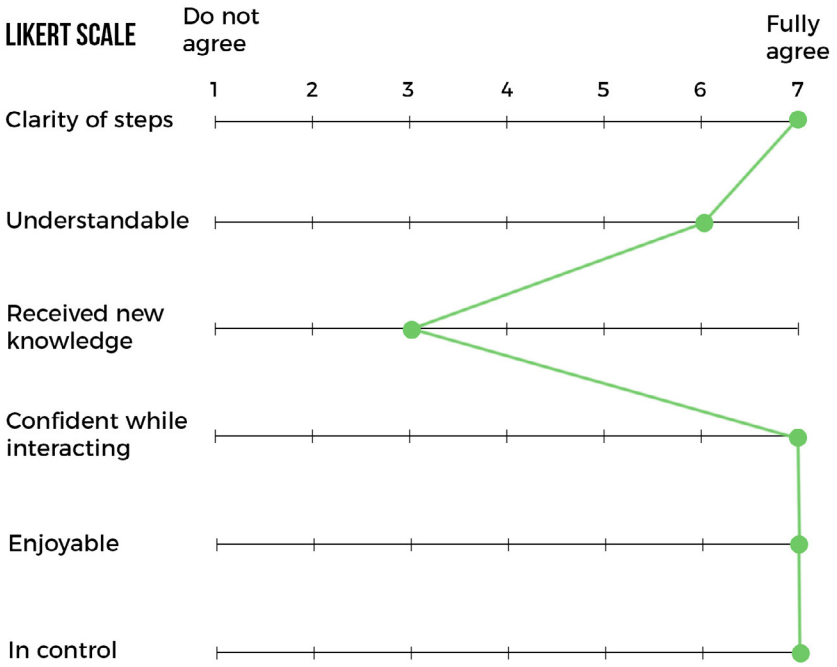


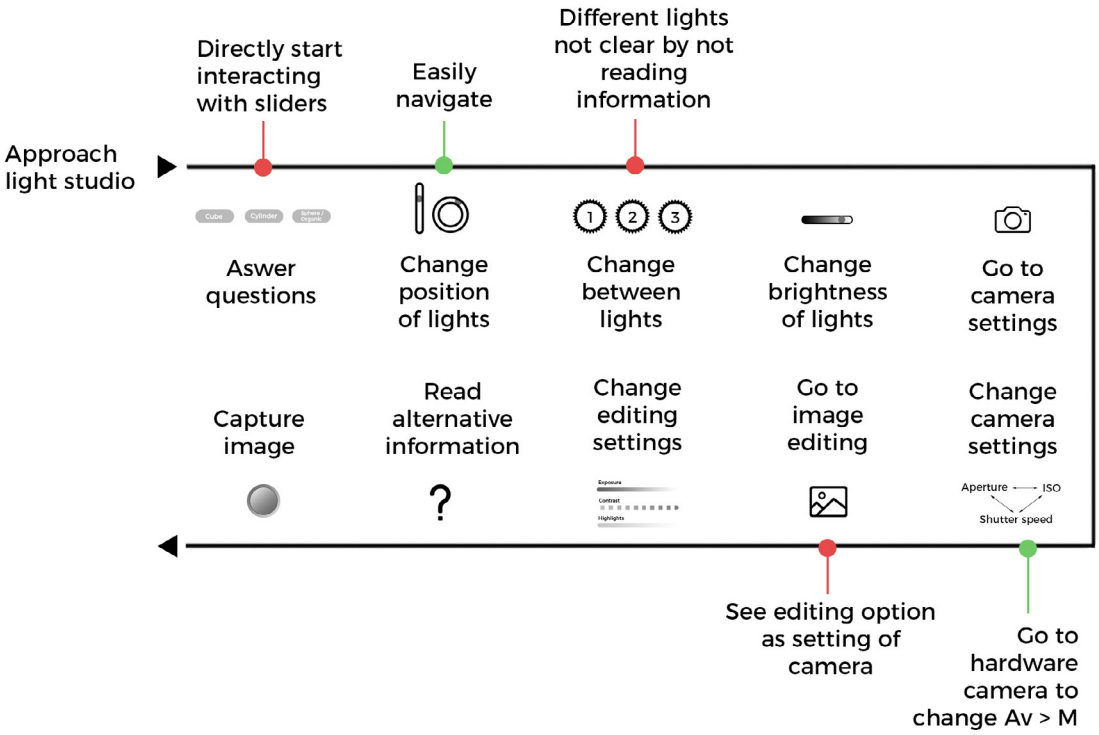
Participant 2
Participant 2 followed the course Design for Visualisation, which included a short photography workshop. It aroused her interest and she followed photography classes at X Delft.



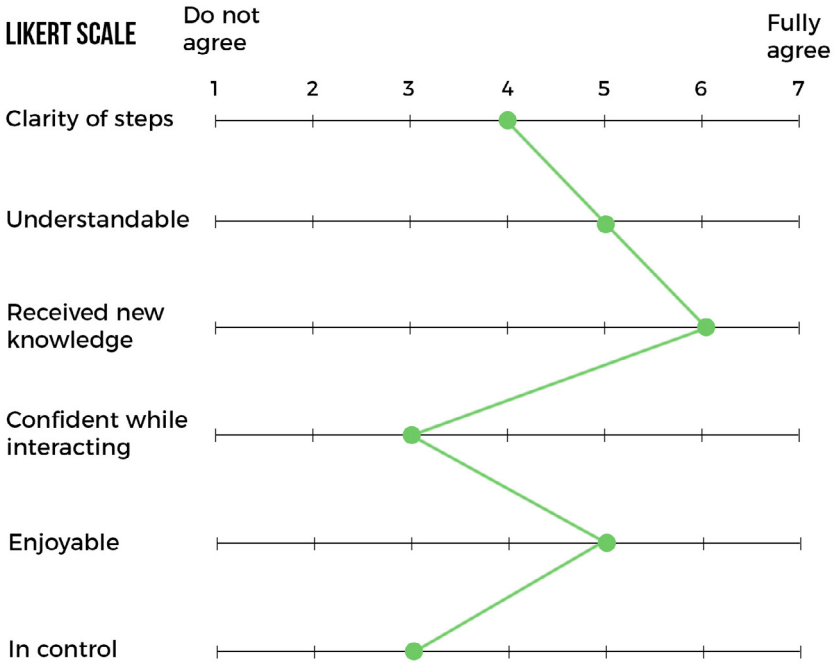


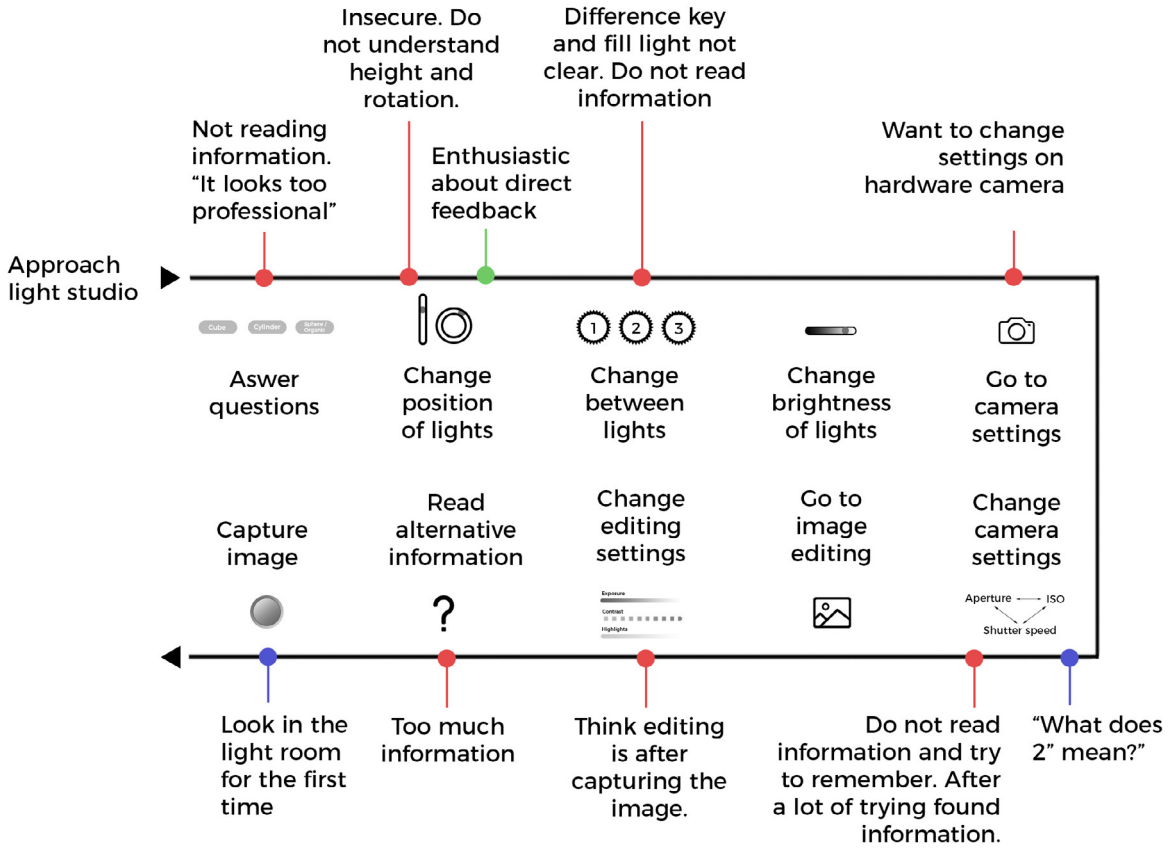
Participant 3
Participant 3 has had photography as a hobby for a longer time. For his student association, he makes photos and teaches new students who also like photography but do not have the knowledge.



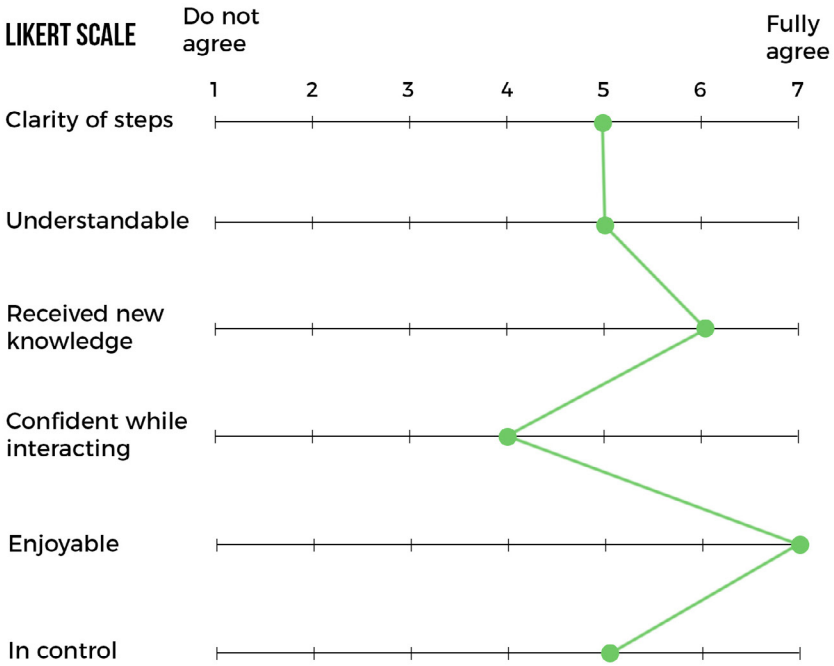


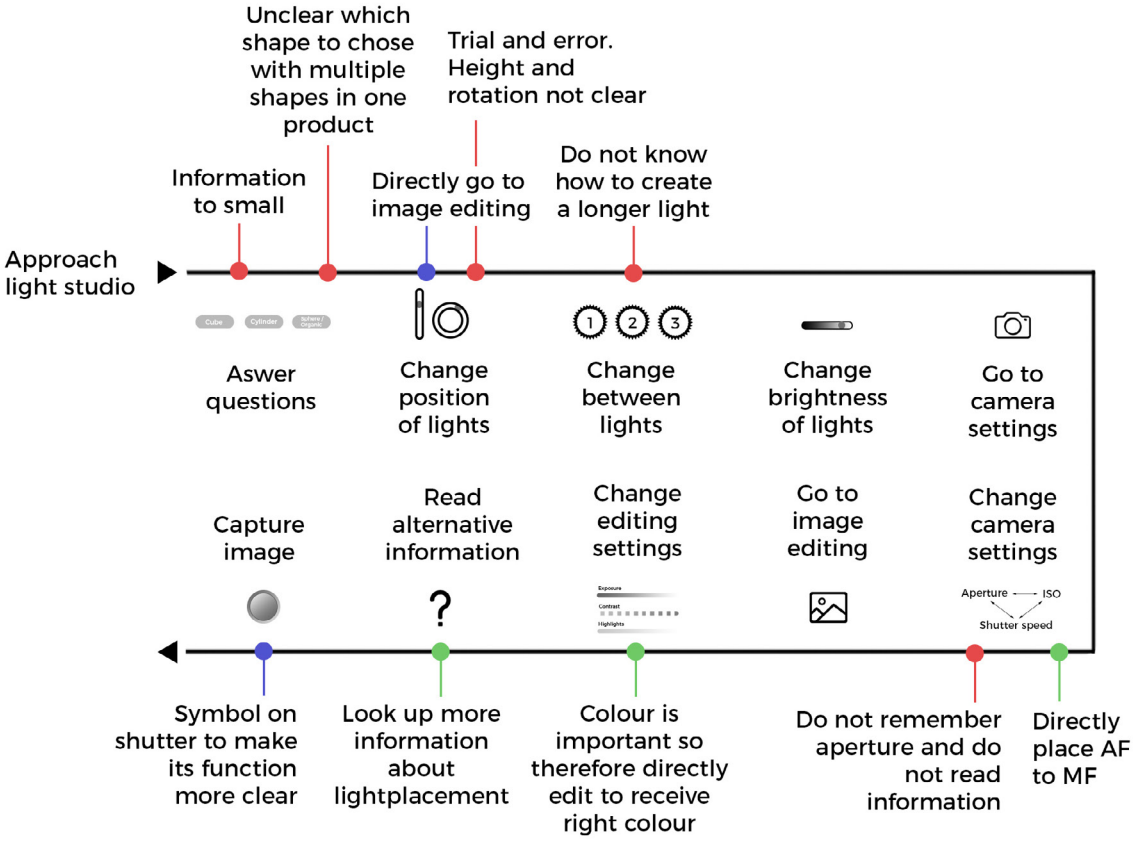
Participant 4
Participant 4 is a second year master student from Taiwan. She has an older DSLR, but besides using the automode, she does not have any knowledge on using the camera.



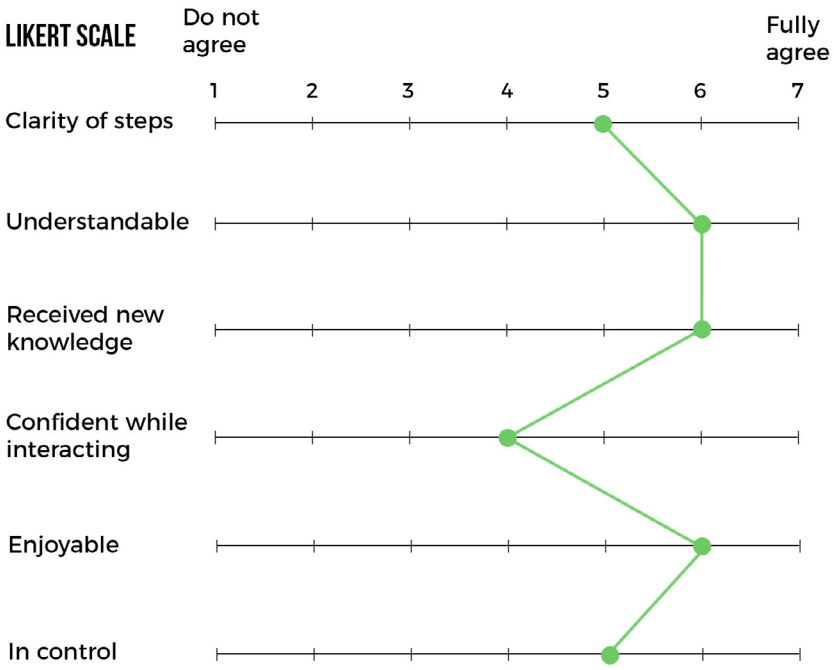


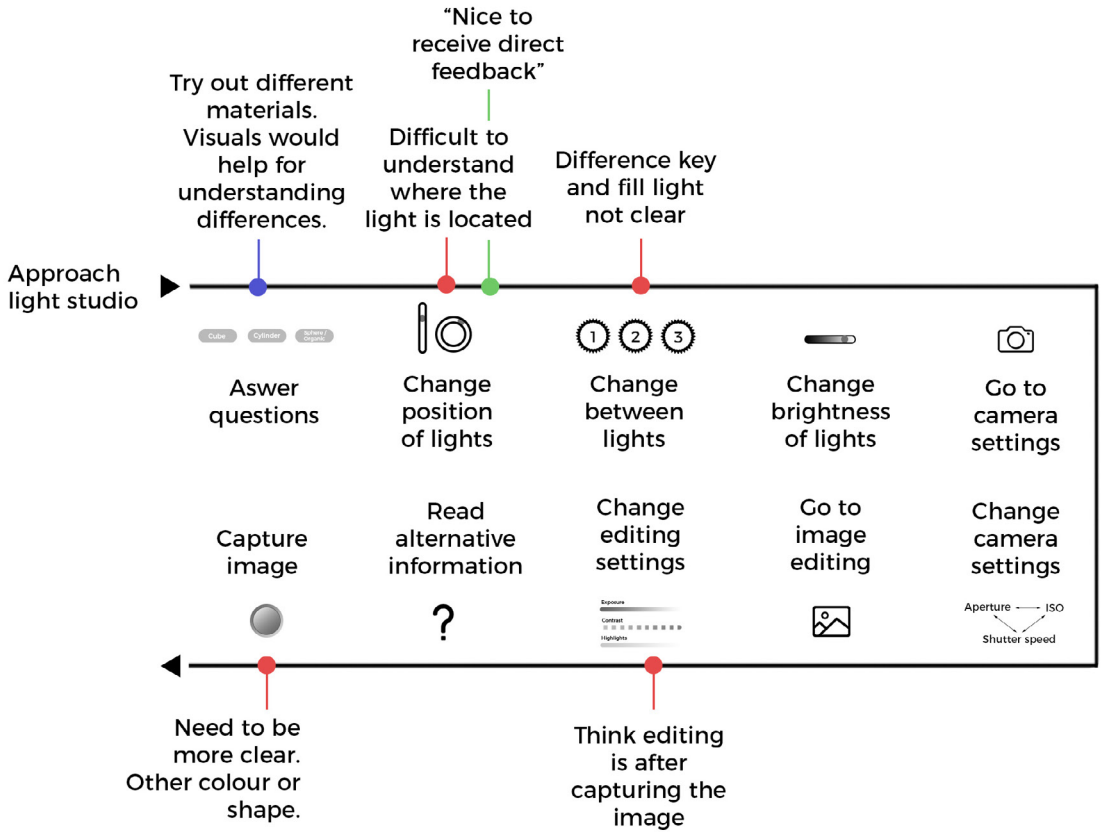
Participant 5
Participant 5 is a graduation student who has an old analog camera. He is not using it anymore and mostly uses his phone. He has no experience with the camera settings.



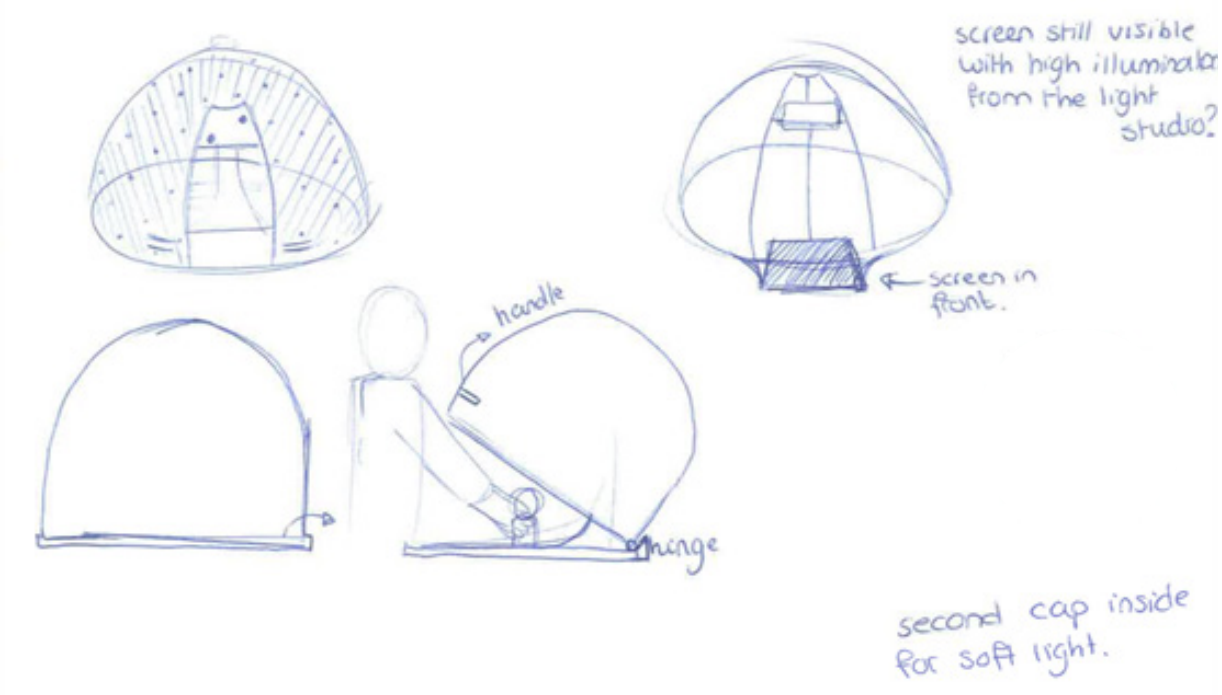


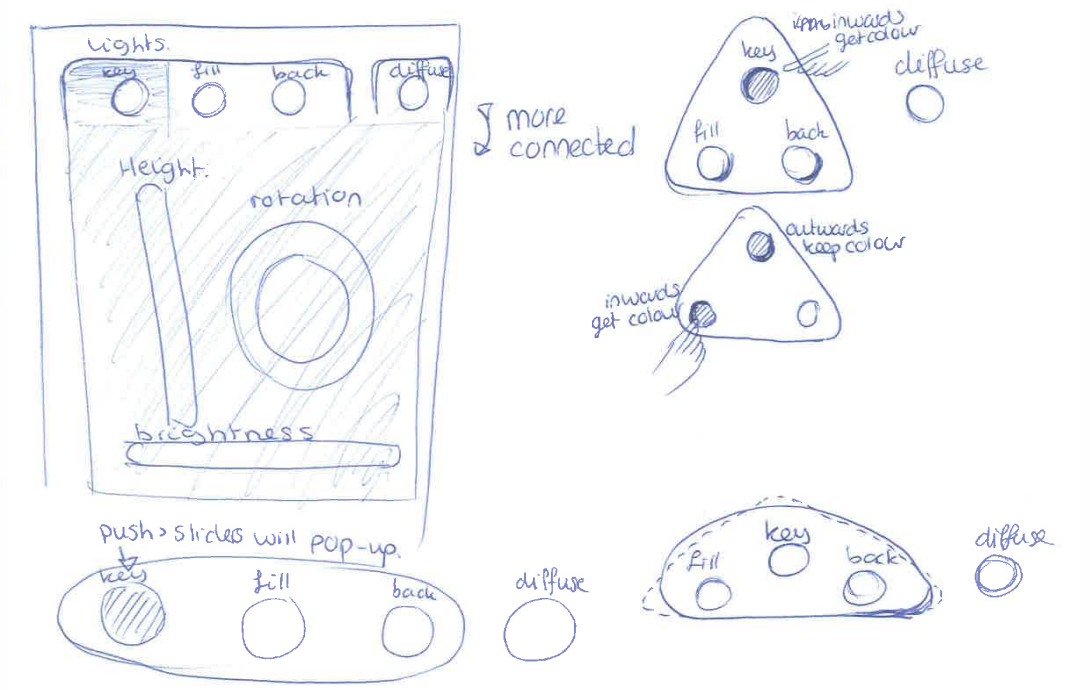
Participant 6
Participant 6 is a first year master student. She does not often use a DSLR, but wishes to use it more. Now she mostly makes quick images with her mobile phone.





APPENDIX J - REDESIGN IDEA SKETCHES





APPENDIX K - REDESIGNED INTERFACE

By opening the link it is possible to see all screens of the interface.
Due to limitations of the program there is one specific flow that can be followed in the first page. When looking to the object placed in the studio and describing this, it is possible to go on to the next question to answer. Other options are clickable to receive the information that would be visible by sliding over the button.

https://xd.adobe.com/view/d4505162-4560-4c2a-b342-e2eb8c802bf6