Indistinguishable likeness

3D replication as a conservation strategy
and the moral & ethical discussions on our perception of art

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“Born originals,
how comes it to pass that we die copies?”

- Edward Young, 1759

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Preface & Acknowledgments

This thesis is born out of a fascination with the introduction of modern technology and material science in the art world. My thesis supervisor at the University of Leiden, Kitty Zijlmans, was supervising a research project within the NWO *Science4Art*-program when she came into contact with Joris Dik from the Technical University of Delft, who was reconstructing Rembrandt's paintings using 3D technology.[1] Whilst supervising this research, they were fascinated by the possibilities that this new technique introduces and were interested to know what discussions will possibly come into play when 3D reproductions are used for the exhibition and conservation of artworks. Kitty Zijlmans approached me in 2016 and asked if I would be interested in executing this research project. As an art historian with an interest in technical art history and a specialization in material science and art conservation, this research topic could not have spiked my interest more.

The questions that triggered me most when I came face to face with a replication of *Het Joodse bruidje* by Rembrandt van Rijn, are related to the connection between the original work of art and the facsimile created with 3D printing (Img. 1). What would the introduction of this technology, with which we can replicate a work of art in its slightest detail, mean to the authenticity of the original? What if we can print a van Gogh in its original colors before the colors had decayed because of exposure to light? What if the technique evolves and prints become more detailed and might even exceed the quality of the original? In order to construct an answer to these questions, I first needed to become more familiar with the technique itself and how a 3D facsimile of an artwork is created.

During my internship at the Technical University of Delft (TU Delft) Willemijn Elkhuizen, PhD candidate at the TU Delft whose research is focused on 3D printing and fine art reproduction, showed me how the scanning and printing of a painting works and what still needs to be developed. After understanding and seeing what this technology can bring us, I figured that it will only be a matter of time before 3D replications will become of such a high quality that they would be indistinguishable from the original but the question remains if we even want to use this technique? I was curious to learn about the ideas regarding 3D replication of people who work in the field of art and people who are new to this development. In order to research this, I developed a questionnaire to interview different people and professionals working at museums in the Netherlands.[2] The questionnaire

[1] Science4Art is a program of the *Nederlandse Organisatie voor Wetenschappelijk Onderzoek* (NWO) that wants to enforce and stimulate research on the conservation and restoration of art. Kitty Zijlmans was part of a four-year project (2012-2016) on the conservation of photographic materials. For more information on the program: https://www.nwo.nl/en/research-andresults/programmes/science4arts (accessed February 2018)

[2] Appendix 1. *Questionnaire: Application of 3D printed replicas*

included questions about the usefulness of 3D replicas for the conservation, restoration and exhibition of art. I also included some questions about a sample, a 3D printed copy of *De Zonnebloemen* by Vincent van Gogh in order to see what TU Delft should improve to make art replications more convincing. The conversations, held between November 2017 and February 2018 have been a great contribution to this research and, moreover, an inspiring experience.

I want to thank Alexandra van Dongen (Curator, Boijmans van Beuningen and Wereldmuseum, Rotterdam), Annemiek Spronk and Wouter van der Horst (Education department, Rijksmuseum, Amsterdam), Benno Tempel (Director, Gemeentemuseum, Den Haag), Lydia Beerkens (Senior conservator, Stichting Restauratie Atelier Limburg (SRAL), Maastricht), Maaike Roozenburg (Designer, Maaike Roozenburg Studio, Amsterdam), Marlies Kleiterp (Head of exhibitions, De Hermitage, Amsterdam), Marrigje Rikken (Head of collections, Frans Hals Museum, Haarlem), Frits Scholten (Senior curator, Rijksmuseum, Amsterdam), Charlotte van Lingen (Senior curator, Kunsthal, Rotterdam), Alice van der Knokke (Conservation and restoration department, van Abbemuseum, Eindhoven), Kees van den Meiracker (Head of collections and conservation, van Gogh Museum, Amsterdam), Lucas Petit (Curator, Rijksmuseum van Oudheden, Leiden), Edwin Buijsen (Head of collections, Mauritshuis, Den Haag), Stijn Huijts (Artistic director, Bonnefantenmuseum, Maastricht), my friends and family for participating and showing interest in this research project and questionnaire. I will gratefully use the information gathered because of your participation.

I would also like to include special thanks to my two supervisors for offering me this opportunity and supporting me during this journey and providing me with all the tangible - 3D samples - and intangible tools I needed to complete this research. I would also like to thank Nynke Feenstra (PhD researcher, Leiden University) for her critical input and expertise in optimizing this research. Lastly, I would like to thank my mother Yvonne Tissen (Teacher of English, Dutch and Spanish, Hogeschool Zuyd, Sittard) and sister Isabelle Tissen (Teacher of English, Fontys Hogescholen, Sittard) for their linguistic input. I hope to be able to understand how the introduction of this technique - and possibly other future techniques - can be used in the advantage of original artworks and in extending their lives forever.

Introduction

The ability to print objects in three-dimensions is a new form of copying that has recently entered the art world. Even though we are familiar with the replication of art, there is a rising awareness of the existence of replicating famous artworks through 3D printing for it offers something new compared to previous replication methods (e.g. photography and film). With 3D technologies it is possible to replicate both texture and the visual qualities of art at a high resolution including every minor detail at a very fast pace. Printing an artwork measuring 1.20 x 1.50 meters will only take up to nine hours to make which is impossible to achieve with other replication mediums or tools.[3] Moreover, the prints are made of polymer, a material resistant to environmental changes (like humidity, exposure to light and temperature fluctuations), making them durable. Nonetheless, the prints are still quite costly to make and the scanning- and printing software is not accessible to everyone making it an exclusive product. The technology still experiences flaws and inaccuracies that have to be overcome in order to convincingly replicate works of art. However, with the rapid speed at which technology has been developing in the twenty-first century it will only be a matter of time before 3D prints become even more accurate, cheaper to manufacture and – because of the internet and social media – accessible to almost everyone. It is inevitable that a large quantity of high quality one–to–one replications of original artworks will be introduced on the art market, in museums and in people's homes.

When I first found myself face to face with a 3D replication of Rembrandt van Rijn's (1606–1669) *Het Joodse bruidje* (1665-1669), printed in 2013 by Océ Technologies B.V. (Venlo) produced by Joris Dik and his team, I started asking myself a number of things (Img. 2,3,4).[4] What happens to the artistic, ethical and authentic value of the original when these copies are introduced? What is the relation between the original artwork and the copy? Can 3D replication also function as a conservation method, and if so, what would this mean for our perception of art? These questions started to sink in and spiked my interest to investigate 3D replication more.

The main question of this thesis is whether 3D printing can be a conservation method and how the introduction of 3D facsimiles will influence our perception of art. This thesis will provide an overview of how we can use – or may not use - 3D printing as a conservation strategy to extend the life of the original artwork. It will provide a way of understanding how we can deal with the technical, art historical and ethical discussions this technique provokes.

[3] Elkhuizen, *personal interview*, October 11, 2017
[4] For more information: https://www.tudelft.nl/2013/tu-delft/wetenschappers-maken-3d-prints-van-schilderijen-oude-meesters/ (accessed February, 2018)

Currently there is limited literature in general on 3D printing of fine art and of which the majority is focused on the technical aspects. Studies that discuss issues that go beyond the technical aspects of 3D printing, such as the significance of 3D replication for restoration, conservation, art history and our ethical beliefs, do not exist. Approaching 3D print from the perspective of conservation studies – a studies that focuses on the practical and ethical ways in which an artwork and its material qualities can be conserved for the present and the future – does not provide any answers, nor a theoretical framework.

Reading the vast amount of textual sources on conservation theory before the introduction of 3D printing provided me with an overview of the ethical questions involving contemporary conservation in general. Within this discourse, I consider Salvador Muñoz Viñas' – head of the conservation group at the University of Valencia in Spain – *Contemporary Theory of Conservation* (2005) as the most important study for it is the first and only source to provide a complete overview of the development of contemporary conservation theory up to now. However, the usefulness of replication was left unanswered in his theory.[5] Texts on replication as a conservation strategy are scarce but one of the few books that tries to answer this question is conservation specialist Monica Marchesi's recently defended dissertation *Forever Young: The reproduction of Photographic Artworks as a Conservation Strategy* (2017).[6] However, Marchesi's book only examines photography and does not analyze the usefulness of more three-dimensional replication methods. The usefulness of 3D print for the conservation of art has, to my knowledge, not been touched upon so far.

This scarcity of literature resulted in field research in which I asked professionals – curators, directors and restorers – and non-professionals throughout the Netherlands about their perspective on the importance of the introduction of 3D printing. Despite the familiarity with 3D printing and art replication of the people interviewed, there is a restraint attitude towards 3D replication of fine art that results in a rejection of the technique. The possible importance of 3D printing is therefore ignored and left undiscovered. This lacuna is what inspired this thesis as I want to find an answer to what the existence of 3D printed facsimiles can mean for the conservation of art and what this means for the perception of the original work of art. I want to go beyond the technical aspects of this replication method and approach 3D printing from the realm of conservation studies, art history, and museum studies.

The 3D print of Rembrandt's *Het Joodse bruidje* will be the center around which this research revolves to unveil the different disciplines – technology, museum studies, conservation, ethics and art history – from which I will draw my conclusion. I will limit myself

[5] Muñoz Viñas, S., *Contemporary theory of conservation*, (Oxford: Butterworth-Heinemann, 2005).
[6] Marchesi, M., *Forever Young: The reproduction of photographic artworks as a conservation strategy*, 2017.

to paintings as different disciplines require different approaches and make this discussion even more complex. In addition to this, the fact that paintings do not have a utilitarian purpose makes their visual features an important asset. This makes accurately copying them a delicate and challenging process with little room for mistakes.

This thesis finds itself at the boundaries of various disciplines such as technology, material science, conservation theory, art history and museum studies. The information gathered first handed from my fieldwork, interviews and the 3D replication of *Het Joodse bruidje,* are the most important sources I will be using in this thesis. Because the fieldwork I conducted was executed in the Netherlands, this thesis is written in a Western setting and with a focus on Dutch museums and the visitors of these museums. I will also be using secondary literature, of which Muñoz Viñas' *Contemporary Theory of Conservation* (2005) is the main study in order to enter the discourse of contemporary conservation. To understand the difficulties faced in the conservation of art in a more practical way, I will be using *Modern Art: Who Cares?* (1997) edited by IJsbrand Hummelen and Dionne Sillé, both specialists in the conservation and restoration of art, a book which tackles the concept of conservation and the difficulties involved using different case studies.[7] I will propose ways in which the 3D printed replica of *Het Joodse bruidje* can be used for the conservation of the original artwork and how it can work in favor of the original by using art historian Nicole Ex's *Zo goed als oud: de achterkant van het restaureren* (1993).[8] Lastly, Marchesi's dissertation considers the ways in which a facsimile can be used for the conservation of art, based on several case studies.

To understand the usefulness of 3D replication and our attitude towards replication, I will further rely on texts such as *Authenticity and Replication: The 'Real Thing' in Art and Conservation* (2012) a cluster of articles that analyze the meaning of replicas throughout time,[9] and Walter Benjamin's *Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit* (1936), in which he elaborates on how our perception of art and replication has changed because of the introduction of photography and future technical inventions that are able to rapidly create very accurate duplicates in large quantities.[10] I want to test if Benjamin's opinion is still accurate in a world of 3D replication. This will become clear by relating Nicole Ex's different types of authenticity to *Het Joodse bruidje,* and by using scholar Thierry Lenain's (Université Libre de Bruxelles) *Art Forgery: The history of a modern obsession* (2011), a book that provides a critical analysis of the problematic

[7] Hummelen, I.M.C.; Sillé, D., *Modern Art: Who Cares? : An interdisciplinary research project and an international symposium on the conservation of modern and contemporary art*, (Amsterdam: Amsterdam, The Foundation for the Conservation of Modern Art ; The Netherlands Institute for Cultural Heritage, 1999).
[8] Ex, N., van de Wetering, E., *Zo goed als oud: de achterkant van het restaureren*, (Amsterdam: Amber, 1993).
[9] Gordon, R.; Hermens, E.; Lennard, F., *Authenticity and replication: The 'real thing' in art and conservation*, (Londen: Archetype, 2012).
[10] Benjamin, W., "Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit", *Zeitschrift für Sozialforschung*, (Frankfurt Am Main: Suhrkamp, 28 (1936)).

dichotomy between different contemporary perspectives on the concept of forgery and how our obsession with authenticity was constructed because of art forgery.[11]

Starting from Nicole Ex's and historian David Lowenthal's similar 'authenticities' mentioned in *Counterfeit art: Authentic fakes?* and using a volume of the Tate Papers (autumn, 2007) published for the *Inherent Vice: The Replica and its Implications in Modern Sculpture Workshop* held at Tate Modern in October of 2007, will help to clarify whether the existence of copies is useful or, instead, may be harmful to the original.[12] I will reflect on these insights together with the outcomes of my internship interviews on *Het Joodse bruidje* to identify the contemporary outlook on authenticity and what complexities arise from the introduction of 3D printed replicas.[13] This will make it possible to conclude what this replication method might mean for the perception of art and the authenticity of the original artwork.

The possibility of the 'authentication' of a 3D replication will be based on results of my internship and by critically reading cultural historian Hillel Schwartz's *The Culture of the Copy: Striking Likenesses and Unreasonable Facsimiles* (1996), a book that tries to make sense of the Western fascination with copies.[14] As it has already been five years since *Het Joodse bruidje* was printed, my case study will be compared to previous replications, like the replication of the Lascaux cave and the recently restored replica of Pieter Brueghel's *De toren van Babylon,* and how the relation between original and copy was interpreted.[15] By doing this it is possible to decide whether and under what conditions a 3D print might become 'authentic'. Lastly, I will deal with the question how we could interpret, understand and handle the introduction of 3D printing techniques as a form of conservation for 3D printed facsimiles. This analysis will clarify whether our perception of art has changed or will change in such a way that we will allow copies to become originals one day.

This thesis consists of five chapters of which the first will introduce what 3D printing is. I will explain how the technique works and what is and what is not (yet) possible at the moment. Subsequently, the concept of conservation will be introduced in the second chapter by

[11] Lenain, T., *Art forgery: The history of a modern obsession*, (London: Reaktion Books, 2011).
[12] Nicole Ex and David Lowenthal both mention various similar ways in which people grant authenticity to objects or works of art. The characteristics on which the value of an artwork is based can be categorized in distinct 'authenticities'. These types of authenticity will be explained furtheron in this thesis.
[13] I did an internship from November 2017 to March 2018 through a collaboration between Leiden University and TU Delft in which I created a questionnaire that was proposed to several major art related institutions and specialists of the Netherlands and to the museum visiting public. For more information: Appendix 1. *Questionnaire: Application of 3D printed replicas*; Appendix 2. *Interview results questionnaire*.
[14] Schwartz, H., *The culture of the copy: striking likeness, unreasonable facsimiles*, (New York: Zone Books, revision 2014).
[15] The restoration of the 110% sized replica of *De toren van Babylon* took place in the Boijmans van Beuningen museum in Rotterdam on the 26th of February 2018. I attended the restoration and interviewed the restorer Eva van Zuilen not only about the material properties of the copy, but also about the reception and interpretation of this copy. For more information: Appendix 5. *Interview: restoration of De toren van Babel replica*.

providing a brief introduction on the history and development of contemporary conservation. ‘Understanding 3D prints as facsimiles in relation to the original’ will provide an analysis of replication methods that are in technique somewhat similar to 3D printing as they rapidly replicate visual images in large quantities like engraving, etching, lithography and photography. Reflecting on the changes in replication and in attitude will explain in what way a 3D printed replica can be valuable for the conservation of art. The fourth chapter considers what questions are asked when the original and its replica are placed next to each other. By introducing the concept of authenticity, it will become clear how the appreciation towards the original has shifted overtime and what the contemporary outlook on authenticity entails. I will introduce replication to the realm of authenticity and the position of the 3D replica discussed, to grasp the relationship between original and copy. To answer the question whether 3D replication can be a conservation strategy and changes the perception of art, chapter five will answer the question if the 3D replica can become authentic and ‘original’. Has the 3D facsimile obtained its own authentic value and should it be conserved like the original it was derived from? This way it will be possible to predict if 3D replication can function as a conservation strategy of itself.

With this thesis, I aim to revise the way art history grants authenticity to artworks and I will address the way authenticity is granted to copies because the relation between original and copy is changing. The introduction of new technology will inevitably blur the line of what is considered to be original and what is considered to be fake for it unveils new dimensions and opens possibilities that were never possible before. Leading to answering the main question, the first chapter, will introduce the 3D printing technique by explaining the technical aspects of the creation of a fine art facsimile. This will show how 3D printing differs from other replication methods in both materiality and the way of creation.

1. 3D printing fine art

3D printing is a technique that has existed since the 1980s, but the technology has recently boomed in various sectors (e.g. the medical and mechanical industry). It is currently possible to copy and print a large variety of objects in different materials like organs, industrial tools and even food. As 3D printing has been developing quickly on a large scale, it could only be a matter of time before this technique entered the art world. In 2013, Joris Dik, Antoni van Leeuwenhoek professor at the Mechanical, Maritime and Materials Engineering (3ME) department, together with his team of the Technische Universiteit Delft (TU Delft), decided to scan and print Rembrandt's *Het Joodse bruidje* in 2013 (Img. 1).[16]

The choice to print *Het Joodse bruidje* was not a coincidence: the irregularities, thick layers of paint and impasto make this work of art interesting to duplicate through 3D printing as the duplication of texture of the work of art exemplifies how advanced and precise 3D printing at present is. Hideo Kodoma, researcher at the Nagoya Municipal Industrial Research Institute, took the first step in the creation of 3D printing as it is known today when he first introduced functional photopolymer rapid prototyping system, a technique that translates visual computer information into a three-dimensional product created by hardening polymer, exposing it to ultraviolet (UV) light (1981).[17] Charles 'Chuck' Hull, co-founder of 3D Systems, was the first person to combine the recently developed technique of stereolithography (SLA) with Kodoma's rapid prototyping. This invention made it possible to print forms layer by layer by curing photopolymers with ultraviolet light lasers.[18] This technique of layering polymers in a cross-sective way is the basis of most 3D printers and the 3D printing techniques we use today.

The technique that was used by TU Delft to print *Het Joodse bruidje* and other works of art is quite similar to Hull's: they use an inkjet-printing technique that prints layers of microscopically small droplets of polymer.[19]

These droplets are printed in a network of small molecular chains that are melted together by UV light (Fig. 1).[20] A three-dimensional shape is constructed by printing multiple layers on top

[16]Joris Dik, Pieter Jonker and Jo Geraedts (TU Delft) have made a high-resolution 3D scan of the painting and collaborated with Océ Technologies BV (Venlo) that printed the painting. The copy of *Het Joodse bruidje* was printed in 2013 and was first exhibited at the *Technart* conference at the Rijksmuseum in Amsterdam on the 23rd of September, 2013.

[17] Noorani, R., "Principles of rapid prototyping", *Rapid prototyping: principles and applications*, (Hoboken: Wiley, 2006), pp. 34-57.

[18] Kocovic, P., "History of additive manufacturing", *3D-Printing and its Impact on the production of fully functional components: Emerging research and opportunities*, (Hershey: IGI Global, 2017) pp.1-21.

[19] The polymers used for 3D printing are very varied, but the most common are Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS) and Polyvinyl Alcohol Plastic (PVA). The density of the droplets can vary, but for printing fine art it is 450 droplets per square inch.

of each other (Fig. 2). However, the technique used to reproduce Rembrandt's painting is slightly different from 'regular' 3D printing because texture is printed on a flat and solid polymer base layer. As this printing technique does not print a three-dimensional object but rather a textured layer, it is also referred to as 2,5D printing.[21] Because each printed layer has a thickness of about 10 µm, it is possible to print at a high resolution with a great amount of detail, so Willemijn Elkhuizen (PhD researcher at TU Delft) states, and this makes it an excellent tool for reconstructing and replicating painted surfaces.[22] Works of art, and especially paintings, are valued because of their visual qualities. So not only the texture of the print has to be accurate, also the color has to be nearly flawless in order to be convincing. Only the final layer of polymer is printed in color. The base and previous layers that are used to create texture are uniform and monotonous (usually white). The colored top-layer is printed with an inkjet printing system that combines the subtractive Cyan Yellow Magenta Key (CMYK) color scheme with black and white to replicate the colors of the artwork (Fig. 3).[23]

Elkhuizen clearly described the way both texture and color are measured by scanning the surface of the artwork with three cameras, a projector and a LED-array lamp which are attached to a horizontally and vertically moving platform (Fig. 4). By looking at the surface from different angles and by combining the information of the three different cameras, it is possible to measure the craquelé and irregularities of the object.[24] The light reflection of the surface is used to calculate the gloss and transparency of the work of art; this is done by aiming light on the paint with the LED-array lamp. Various pictures are taken with and without reflection of the surface. The information of the polarization process is combined and the amount of gloss on the artwork can be calculated and added to the print's final layer.[25]

Even though Elkhuizen remarks that 3D printing fine art is promising, there are still obstacles to overcome in order to be able to print convincing reproductions and replicas of artworks that are true to their original. A painted surface is constructed by layering a large variety of materials that each have their own structure, color and transparency. As Elkhuizen describes, a 3D print is build up out of layers, just like a painting, but these prints' layers are made of the same polymer, color, transparency and thickness and it is only the final layer

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[20] Wachowiak, M. J.; Karas, B. V., "3D-scanning and replication for museum and cultural heritage applications", *Journal of the American institute for conservation*, (Abingdon: Taylor and Francis, 48 (2009) 2), pp. 141-145.
[21] Elkhuizen, *personal interview*, October 11, 2017.
[22] Elkhuizen, W*., Reproducing oil paint gloss in print for the purpose of creating, reproductions of Old Masters*, (San Francisco: SPIE, 2014), pp. 8-9.
[23] Chen, G., et al. *Color 3D printing: Theory, method and application*, (Rijeka: IntechOpen, 2016), pp. 26-31.
[24] Elkhuizen, W., *Reproduction of gloss, color and relief of paintings using 3D scanning and 3D printing*, (Geneve: The Eurographics Association, 2017), pp. 183-187.
[25] Elkhuizen, *personal interview*, October 11, 2017.

that is treated with color.[26] According to Elkhuizen, the prints still lack the depth the artist created by using transparency and different materials, which can make the print come off a little static and frigid. A way to overcome the lack of transparency is by developing gloss as an addition to the final layer. The reflection of light and different grades of reflection on the surface might make the print more convincing and 'vivid'.[27]

Elkhuizen remarks that the technique has to overcome another obstacle, that it is not possible to print every painting: it has to have little transparency and cannot have creases that are too deep as the scanning equipment is unable to measure this. Both cameras have to be able to scan the same spot on the surface in order to gather the information needed to calculate three-dimensional data. Deep incisions or high angled irregularities on the surface are nearly impossible to scan, leading to errors and inaccurate information. It is also hard to print these irregularities as a 3D print is build up from bottom to top which makes it impossible to print overhanging material or paint without using a supporting material (Fig. 2). Moreover, today's printers are not capable of printing with the same resolution with which the scanner captures the surface. The scanning equipment is able to measure smaller details of 60 µm, whereas the printer can only print details up to 10 µm. This results in visible pixels on the surface and possible inaccurate information in the appearance of the original artwork.

Another hurdle that needs to be taken is related to the print's color and reflection. It is still very hard to print certain colors - boneblack for instance - with inkjet printing as the print is constructed by combining CMYK colors.[28] Due to the incapability of the human eye to separate different colored dots, the spectator considers them as one mixed color. Elkhuizen says that this results in the possibility to see pixels, a limitation of mixed colors and a lack of depth, something that would never happen with a painted artwork because artists' colors are actually mixed and do not rely on the deception of the human eye.[29]

3D printing will undoubtedly develop and it will be a matter of time before technology overcomes the difficulties mentioned. As I have discovered during my fieldwork, there is a rising awareness in the existence of this technique and the possibilities it creates for the reconstruction, replication and possible conservation of artworks. More people, specialists and researchers become involved in the realm of fine art printing as the technique is already used to restore destroyed archaeological monuments and recreate sites that would be inaccessible otherwise, for example *The Valley of the Kings* in Egypt where the Spanish

[26] Elkhuizen, W., et. al., *Digital manufacturing of fine art reproductions for appearance*, (Delft: TU Delft, March 2018),https://www.researchgate.net/publication/324171528_Digital_Manufacturing_of_Fine_Art_reproductions_for_appearance (accessed March, 2018).
[27] PhD Willemijn Elkhuizen is currently experimenting with capturing gloss and developing an effective gloss reproduction system for 3D printing. As case studies she often uses artworks.
[28] Chen, G., 2016, pp. 32-33.
[29] Elkhuizen, *personal interview,* October 11, 2017.

company *Factum Arte* has replicated the Egyptian tombs.[30] The interest in fine art reproduction and the conservation of our cultural heritage generates more funding and causes the technology to develop even faster.[31] It will be a matter of time before it *will* be possible to develop indistinguishable copies of originals but the question is if it is *required* to happen. It is necessary that the moral and ethical discussions caused by the introduction of this technology are analyzed and explained, to use this technology to art's advantage.

The first step to see if 3D replication can be a conservation strategy and what it means to the perception of art, is to understand how conservation originated and what contemporary conservation is. This will provide a framework from which it will be possible to introduce 3D replication as a conservation method as will be described in the following chapter.

[30] Zaleweski, D., "The factory of fakes", *The New Yorker*, (New York, 28th of November 2016) https://www.newyorker.com/magazine/2016/11/28/the-factory-of-fakes (accessed November, 2017).
[31] Appendix 4. *Advise for the Technical University of Delft*, 2018, p. 6.

2. Contemporary conservation and 3D printing

As conservation studies is the main discipline this thesis draws from, it is important to understand what conservation is and how contemporary conservation has developed into becoming the discipline it is today. First, I will clarify what the difference is between conservation, preservation and restoration because there is an overlap between and misconception about the three terms. I will then briefly elaborate on conservation and its history. Lastly, I will introduce 3D printing in the realm of contemporary conservation.

2.1 The difficult concept of conservation

Conservation is a complex concept. Although it is a commonly known notion that is used frequently. Yet to define it, is not as easy as it seems. It gets even harder if conservation has to be defined in its relation to preservation and restoration: it is not easy to draw a clear line between the activities that involve preservation, conservation and restoration for they need each other and interact mutually. According to Muñoz Viñas, conservation is hard to define because it is a complex activity that involves many partakers and in comparison to restoration and preservation, it has just recently been acknowledged as a profession, thus lacking a clear framework.[32] IJsbrand Hummelen and Dionne Sillé's *Modern Art: Who Cares?* (1999) is the outcome of extensive research and a conference on this complex topic. Hummelen and Sillé have tried to develop a methodical approach as to how we should deal with the care for modern art. Even though this book was written almost two decades ago, it is still up to date and comparing the case studies in this book will give insight in what conservation is and how conservation differs from preservation and restoration in practice.[33]

As conservator Louise Wijnberg says in a report on the conservation of monochrome paintings in the collection of het Stedelijk Museum in Amsterdam: "The aim of restoration is to return the work as closely as possible to its original form, using the authentic material (…)." [34] Muñoz Viñas adds that restoration is a noticeable practice: the work of art does not look like it did before the treatment and its condition has improved to a less damaged and (possibly) 'healthier' earlier state that Muñoz Viñas calls the 'preceding' state.[35] Returning to monochromes, in the case of Ellsworth Kelly's *White Triangle with black curve* (1972) (Img. 2), the restoration in 1993 by Wijnberg and fellow conservator Elisabeth Bracht entailed the

[32] Muñoz Viñas, pp. 8-13.
[33] Hummelen, Sillé, 1999, pp. 308 – 312, 397.
[34] Wijnberg, L., "The conservation of monochrome paintings", *Modern Art: Who Cares? An interdisciplinary research project and an international symposium on the conservation of modern and contemporary art*, (Amsterdam: Amsterdam, The Foundation for the Conservation of Modern Art; The Netherlands Institute for Cultural Heritage, 1999), p. 363.
[35] Muñoz Viñas, 2005, pp. 16-17.

cleaning of the discolored white surface that was browned because of water damage and previous acts of retouching of the varnish.[36] This example thus underlines the problem that restoration leaves visual marks of the treatment as Muñoz Viñas suggested.[37]

Whereas restoration often stays visible, preservation is a less visible way of treating an artwork according to Muñoz Viñas. Preservation to Muñoz Viñas serves as a 'freeze in time' in order to *restore* other features of the object. He also mentions that restoration and preservation need each other: one cannot retouch the colors of *White Triangle with black curve* if the canvas underneath has not been preserved well by keeping the material conditions stable and secure.[38] Wijnberg and Bracht have removed the top layer and replaced it with a more stable layer to provide the new layers that were added as restoration with a stable base.[39] Besides the difference in noticeability, Hummelen remarks another significant difference between restoration and preservation: in contrast to restoration that is almost always executed directly on or to the object, preservation treatments can be used both directly and without having to touch the object, better known as preventive conservation.[40] In the case of *White Triangle with Black Curve* preventive conservation regarding the reparation of the ceiling of het Stedelijk Museum, prevented it from leaking again, recreating a safe environment for the artwork as Bracht says.[41]

With this definition of preservation and restoration, conservation can be explained in a narrow sense and a broad sense, according to Muñoz Viñas: narrow is the activity of keeping a work of art the way it is.[42] Bracht conserved *White Triangle with Black Curve* in Muñoz Viñas' narrow sense by varnishing the surface to seal the paint preventing the colors from changing.[43] Muñoz Viñas says conservation in the broad sense is a sum of activities that make the maintenance of the appearance of an artwork possible.[44] Thus Bracht's removal of the brown drip marks and the development of a stable detergent to keep the delicate material intact would be in line with Muñoz Viñas description.[45] Simply put: conservation can be seen as the umbrella term of practices – including preservation and restoration – that *keeps* the (aesthetic) quality of the work of art the way it is. However, Muñoz Viñas' remarks that not all restoration or preservation actions are by definition a way of conservation; conservation is sometimes quite the opposite of restoration for conservation does not want to return the

[36] Bracht, E., "The restoration of Kelly's works at the Stedelijk Museum", *Modern Art? Who Cares*: *An interdisciplinary research project and an international symposium on the conservation of modern and contemporary art,* (Amsterdam: Amsterdam, The Foundation for the Conservation of Modern Art; The Netherlands Institute for Cultural Heritage, 1999), p. 251.
[37] Muñoz Viñas, 2005, pp. 16-17.
[38] *Ibidem*, pp. 19-21.
[39] Bracht, 1999, pp. 252-253.
[40] Hummelen, Sillé, 1999, pp. 319 – 321.
[41] Bracht, 1999, pp. 251-253.
[42] Muñoz Viñas, 2005, p. 14.
[43] Bracht, 1999, p. 253.
[44] Muñoz Viñas, 2005, p. 14.
[45] Bracht, 1999, p. 253.

object to a *previous* state but tries to keep it in the *current* state. To understand what conservation is exactly, it is important to further elaborate on how this discipline came into existence.

2.2 A brief introduction in conservation history

In the introduction of his overview on the development of contemporary conservation, Muñoz Viñas says that the origins of conservation can be traced back to the Enlightenment when science became the method to reveal truth and art became more accessible to the public.[46] The growing interest in art was a result of the rise of nationalism in Europe starting with the French Revolution in 1789, which caused a romanticized desire to create a distinct 'national identity'. This led to an increase in interest in cultural heritage and the need to optimize the condition of the objects became essential for the creation of a national identity. This trend resulted in an admiration for monuments and the romantic belief in the artist as the individual that would make it possible to express these patriotic dreams as described by Muñoz Viñas.[47] Nicole Ex demonstrates in her overview on restoration history that these developments resulted in the need to *conserve* the objects that represent national identity and to maintain their cultural integrity.[48]

More than ten years after Muñoz Viñas' and Ex's theories, paper conservator Monica Marchesi remarks that before professionally trained people like herself performed conservation treatments, artists and craftsmen practiced the craft.[49] Marchesi mentions fellow conservator Vivian Saaze who stated, a few years earlier, that the start of the recognition of conservation as a specific discipline in need of being executed by professionally trained people is often related to the repeatedly described controversy between the first two conservation theorists: the French architect Eugène-Emanuelle Violett-Le-Duc (1814-1879) versus the British critic John Ruskin (1819-1900).[50] Ex, Saaze, Muñoz Viñas and Marchesi, all refer to this example to illustrate the problems surrounding the existence of conservation.[51] I think Ruskin and Violett-Le-Duc clearly exemplify two extremes that are still illustrative for present issues in conservation. Muñoz Viñas describes that Ruskin was convinced that the most 'pristine' state of historical objects feature visible signs of time (also known as *patina*) whereas Violett-Le-Duc considered the state where the artist's

[46] Muñoz Viñas, 2005, pp. 1-5.
[47] *Ibidem*, pp. 6-10.
[48] Ex, N., van de Weteringen, E., *Zo goed als oud: de achterkant van het restaureren*, (Amsterdam: Amber, 1993) p. 70.
[49] Marchesi, 2017, pp. 30-31.
[50] van Saaze, V., *Installation art and the museum: Presentation and conservation of changing artworks*, (Amsterdam: Amsterdam University, 2003) pp. 37-39.
[51] Ex, 1993, p.70; van Saaze, 2003, p. 37-39; Muñoz Viñas, 2005, p.6; Marchesi, 2017, pp. 30-31.

intention is protected as the perfect state.[52] According to Saaze, this difference results in radically different conservation strategies: if one follows Ruskin's perspective, little to no changes can be made to the object as its *patina* has to remain intact; whereas Violett-Le-Duc's approach permits almost any treatment as long as it is in line with the artist's intention, risking the creation of 'pristine' conditions that might have never existed and were never part of the original idea of the artist.[53] Keeping Muñoz Viñas' and Saaze's theories in mind, introducing 3D printing in this discussion would enhance the idea that Violett-le-Duc and Ruskin are total opposites. Following Ruskin's perspective, on the one hand, 3D replication would be unacceptable as the original material is completely lost and the object or artwork would fail to provide historical information to the person handling or viewing it. To Violett-le-Duc on the other hand, 3D replication would be a highly valued tool as he does not care about the 'original' material and it would be easily possible to print the 'prestine' state intended by the artist.

The controversies between the two mark the issues embedded in what I refer to as 'traditional conservation'. The goal of traditional conservation in Marchesi's words can be described as the aim to care for the information – related to its historicity (Ruskin) or the artist's intention (Violett-Le-Duc) – physical objects provide us with.[54] I chose the word 'traditional' because the goal of conservation and the discussion exemplified by the differences between Violett-Le-Duc and Ruskin have not changed over time.[55] A good example of the currentness of the tension between material and conceptual authenticity is the restoration of Pino Pascali's *Campi arati e canali d'irrigazione* (1967) described by Caroline van der Elst and Alan Phenix, both painting conservators (Img. 6). Pascali's artwork at the moment of restoration consisted of corroded trays with a 'sky-blue' liquid leaking out of the artwork. Van der Elst and Phenix question whether one would replace the corroded material and the lost blue liquid with new materials as the artist intended (Violett-Le Duc) or if it would be better to exhibit the trays without water to keep the material authenticity intact, keeping its historicity alive (Ruskin). The decision-making on restoration of Pascali's artwork that van der Elst and Phenix had to face in 1997 exemplifies the difficulty of reconciling two important demands: a dilemma that theorists still try to resolve today in 2018.[56]

All previously mentioned conservation and restoration specialists say when the involvement of natural sciences increased where authenticity was looked for later changed from an

[52] Muñoz Viñas, 2005, p. 6.
[53] van Saaze, 2003, pp. 39-41.
[54] Marchesi, 2017, pp. 28-30.
[55] Tissen, L.N.M., *"*Restauratie van een kleurloos vlak: Problematiek van conservering en restauratie van moderne kunstwerken, geanalyseerd aan de hand van *Achrome* (1962) door Piero Manzoni*", Conservation and restoration of cultural heritage*, (Amsterdam: University of Amsterdam, 2015), pp. 6-8.
[56] Hummelen, Sillé, 1999, pp. 397, 402 – 405.

information-based to a more material-based approach. Science was and is often considered the way to reveal the validity in cultural heritage, which can only be found in materiality.[57]

This is the first indication of what Muñoz Viñas and Marchesi describe as the 'material turn' in conservation studies and a point in time where one of the essential features of contemporary conservation is rooted: its close relation to the object itself as its materiality proves 'hard' measurable evidence of history.[58] According to Muñoz Viñas, the focus of conservators is based on practices that involve the materiality, production and function of the conservation object.[59] He observes that from the mid 1960s onwards, when historian Cesare Brandi (1906-1988) published *Teoria del restauro* (1963), aesthetic values of the artwork have regained importance and have changed the attitude of conservation theory as one to express aestheticism through material science.[60] The latter is another key feature of what Muñoz Viñas calls 'classical' conservation, in which historical evidence can only be revealed by the object itself and cannot be added to the object.[61] As remarked by Van Saaze, aesthetic and authentic value is already embedded in the object itself and Brandi, therefore, stated that minimum intervention in the object's materiality is desired. This material 'fetishism' has had a great influence on the attitude towards the use of a replica as a conservation method. During this period in time, conservation should avoid the elimination and alteration of the original material, says van Saaze.[62] The effect of the replica is only briefly mentioned in this context by Muñoz Viñas and he remarks that we would always prefer the original to the replica, despite its quality as it does not carry original material and has no connection to the artist. He adds that this principle encourages the removal of non-original materials that disfigure the aesthetic quality of the 'original' material.[63] What Muñoz Viñas fails to see however, is the way in which a copy actually *can* solve this issue and help Brandi's wish to keep the authentic material intact. In this sense using a 3D print of *Het Joodse bruidje* as a conservation tool would make it possible to conserve both the authentic material quality of the original painting and the aesthetic 'pristine' condition the original once had, without having to interfere and possibly 'damage' the original material.

In *Modern Art: Who Cares?* (1999) conservation specialist Ijsbrand Hummelen discovered that with the introduction of artworks made of transient materials we have become even more aware of the materiality of the object and are obsessed with an artwork's material quality as the artworks decay rapidly. It also became clear that various people such

[57] Throughout this thesis materiality means the quality to be composed of matter. (Oxford Dictionary, 2018).
[58] I want to emphasize that the material turn did not just took place in conservation studies, but other disciplines in the humanities and in sociology (e.g. museum studies, art history and history) experienced a similar shift in the way knowledge is perceived.
[59] Muñoz Viñas, 2005, pp. 1-5.
[60] *Ibidem,* pp. 8-13.
[61] *Ibidem,* pp. 90-93.
[62] van Saaze, 2003, pp. 41-43.
[63] Muñoz Viñas, 2005, pp. 83-87.

as curators, conservators, owners and the artist have to be taken into account in the decision-making of conservative practices of these types of artworks.[64] According to Muñoz Viñas this was the start of contemporary conservation as we know it today and made it to become a multidisciplinary concept in which the conservator has the difficult task of meeting the different desires of various individuals involved.[65] Hummelen draws from his experience that the conservator has the difficult task to decide what is more important: is it the object's materiality and 'health'? Is it the artist's – who is often still alive in these cases - intention? Is it the owner of the artwork? Is it the symbolic function of the artwork to the viewer, and which symbolic function is more important? The difficulty and involvement of such a vast number of partakers led to the condition of reversibility and the sustainability of treatments in order to ensure that conservative treatments were not permanent because thoughts may change over time.[66] As Hummelen says, this has also created another feature that is significant and difficult to contemporary conservation; the treatment of every conservation object as an individual case with its own needs, implying that there are no rules or a strict framework to rely on.[67]

Analyzing the work of practicing conservators like Marchesi and Van Saaze, it becomes clear that there are no strict rules to follow and many different people are involved. Then, what are the contemporary requirements for a good conservation? According to Muñoz Viñas: "The conservator should possess sound technical knowledge, which is both tacit and explicit; solid scientific, artistic and historical training; and good communicative skills."[68] He adds that any conservation action can be acceptable as long as the decisions made are in favor of the people concerned and complementing what future people might expect from the objects we are taking care of.[69] This value-led approach of conserving objects is rather controversial and impossible to achieve: Muñoz Viñas suggests that the contemporary conservation treatment needs to meet both the requirements of the present and the future, of which the ethics are unpredictable and possibly controversial. Besides, it is unclear who he specifically means with 'affected people': it would be hard – if not impossible - to decide whose values are more important and have to be kept in mind and it is even harder to decide the values of future people. At the end of his book, Muñoz Viñas briefly mentions that replication might be an acceptable solution to this issue in contemporary conservation as long as the object's symbolic function is more important than its value as historical evidence. According to him copying can only be a solution if no better conservation

[64] Hummelen, Sillé, 1999, pp. 308 – 312.
[65] Muñoz Viñas, 2005, pp. 191-197.
[66] Hummelen, Sillé, 1999, pp. 308 – 312, 397.
[67] *Ibidem*, 1999, pp. 196 - 201.
[68] Muñoz Viñas, 2005, pp. 196-197.
[69] *Ibidem*, pp. 212-214.

options exist.[70] It is true that a copy can be the solution, but Muñoz Viñas comment implies and confirms his previous statement that a copy is in any case less valuable than an original.

I think this is a rather bold statement to make with the little information he provides us with the possible useful ways in which a replication can be a conservation tool that is not limited to objects with a symbolic function.[71] Historians Brigitte and Gilles Delluc describe the prehistoric cave in Lascaux as one example of an accepted facsimile that was made in order to conserve the historical and symbolic function of original prehistoric paintings (1984). It was placed only 200 meters from the original cave, maintaining the close bond with the original and its makers without having to damage the original with the presence of people.[72] The facsimile clearly did not solely conserve the symbolic function of the cave as Muñoz Viñas suggests. Delluc and Delluc say the opposite: the facsimile conserved the original cave and its historical value by providing the viewer with the same paintings at the same location, causing an equal or even more intimate experience than the original as one can come closer to the murals and inspect them.[73] Even more significantly is *The Guardian* in 2016, announcing that *Lascaux II* became a French *historical* monument stressing its historical value and putting the facsimile in the same realm of value as the original, opposing Muñoz Viñas' statement.[74] I think 3D printing can achieve the same way of conservation as *Lascaux II* did. The only – maybe important – difference is that *Lascaux II* was still a handmade copy that took time to manufacture, whereas a 3D print is constructed faster and mechanically without the artistic intervention of men. Also, on the basis of my fieldwork I could conclude that the rejection of the 3D print of *Het Joodse bruidje* is because it is not a three-dimensional work of art like *Lascaux II.*[75] Why is the replication as a conservation strategy for a painting less accepted than a replication of a three-dimensional object?

2.3 3D replication as a conservation strategy

The interviews I conducted with the Dutch museum professionals revealed that the reserved attitude towards 3D replication as a conservation strategy for paintings is, first of all, related to the difficulty of understanding a 3D print as a facsimile.[76] A facsimile is an exact copy in

[70] Muñoz Viñas, 2005, p. 204.
[71] Symbolic function: Significant purely in terms of what is being represented or implied.
Historic function: Of or concerning history or past events.
Oxford Dictionaries: https://en.oxforddictionaries.com/ (accessed March, 2018).
[72] Delluc, B., Delluc, G., "Lascaux II: a faithful copy", *Antiquity* (Cambridge: Cambridge University, 58 (1984) 224), pp. 194-196.
[73] *Ibidem.*
[74] Bryant, J., **"**Prehistoric cave art celebrated at new Lascaux center in Dordogne", *The Guardian*, December 15, 2016, https://www.theguardian.com/travel/2016/dec/15/prehistoric-cave-art-lascaux-dordogne-france-grotto-replica (accessed March, 2018).
[75] Appendix 3. *Interview results,* 2018, pp. 3-6.
[76] *Ibidem.*

both visual characteristics and in materiality.[77] French literature scholar Gérard Genette explains in his book in *The work of art: immanence and transcendence* (1997) that the rejection of the 3D print of *Het Joodse bruidje* is caused because it is a *painting* that is reproduced: a medium of unique existence.[78] Every feature of the original can be indistinguishably reproduced but the materiality of the reproduction is not the exact same.[79] As Marchesi points out, reproduction is slightly more accepted for the conservation of photographs for example.[80] Commonly accepted is that, since photography is a reproduction method in itself, it is adapted to a plural existence in visual quality as well as materiality: something that is uncommon for the existence of paintings. The impossibility to create complete material and visual similarity is what hinders the acceptance of 3D reproductions of paintings, following Genette: a hand-made replica of *Het Joodse bruidje* can never be as visually accurate as a photograph and the characteristic patina of time and craquelé would be lost. A photograph is visually more correct than a hand-made copy, but it lacks three-dimensionality and materiality.[81] The way in which 3D printing differs from previous technical replication methods however, lies in the fact that both texture and color can be replicated in the finest detail: even the authentic features of the original, like color decay and craquelé can be saved without having to touch or damage the original, even without having to present a 'false' truth. Even though the 3D print's materiality is different from the original, it is almost impossible to distinguish the print from the original, especially if we would frame the print, and put them next to each other. The natural distance with previous technical replication methods because of a shortcoming in materiality, creating an obvious difference between original and copy, can now be overcome since the 3D print of *Het Joodse bruidje* looks and feels the same as the original. Can 3D replication thus be the solution to the problem of materiality in technical reproduction methods that made it unacceptable to conserve a painting?

During my conversations with professionals dealing with art I concluded that there are a few situations in which 3D replication for the conservation of paintings will be allowed nowadays. The first way in which the print of *Het Joodse bruidje* is an acceptable replacement according to Ex, is when society decides that it wants to prevent the disappearance of the original and together with the controversial wish to conserve the original context in which the work of art

[77] The word facsimile originates from the Latin words '*fac*' and '*simile*', literally meaning 'make-like'. In the late 16th century the term existed originally as fac simile, denoting the making of an exact copy. Glare, 2012, http://www.oxfordscholarlyeditions.com/ (accessed March, 2018)
[78] Genette, G., *The work of art: immanence and transcendence*, (London: Cornel University, 1997), pp. 29-35.
[79] *Ibidem.*
[80] Marchesi, 2017, pp. 79-84.
[81] Genette, 1997, pp. 34-35; 40-42.

was created.[82] I think the print of *Het Joodse bruidje* would in this case function like *Lascaux II* as a tool to conserve the original way in which Rembrandt's painting was displayed. In Ex's words, the replication would augment the experience of the site more than any other replication method, since both visual quality and texture are reconstructed, thus leaving the viewer with a more convincing encounter. Bringing 3D print into Marchesi's theory, the durability of 3D print's materiality would make it much easier to correctly 'restore' the painting in situ: if the 3D print has decayed, the old one can easily be reprinted and replaced with a newer version.[83] I would therefore agree with Marchesi that (3D) replication enables the possibility to replace objects that would otherwise be damaged in a way that would prevent them from being on display as their visual and material state is unsuitable for presentation to the public.[84] In line with Muñoz Viñas' wishes of a contemporary conservation to be precise and scientifically correct, the accurate facsimilation 3D printing would keep the original's integrity intact. Moreover, the existence of the 3D replica of *Het Joodse bruidje* allows for various versions of the original. This is in line with the value-led approach of Muñoz Viñas, in which a variety of people from different cultural backgrounds and ethical believes that feel a connection with the original are taken into consideration. Even though the existence of copies is hardly acceptable for Muñoz Viñas, the existence of 3D replication could in this case be the ultimate conservation strategy.[85]

The majority of the specialists I spoke with suggested that another acceptable way of using *Het Joodse bruidje* is as a way of documentation for conserving what we know about the original.[86] The way in which a 3D print is constructed was considered especially useful: as Elkhuizen and Dik say, intensive planar surface research and material scanning is necessary in order to come up with the information needed to print a work of art in such detail. Through the 3D scanning and topographical scanning needed in order to create a copy, it is possible to digitally save and store information that lies under the painted surface.[87] Thus, in Dik's words, 3D replication provides a deeper understanding about the painting itself that goes beyond the surface. 3D scanning makes it possible to document material information about the painting that might never be rediscovered in the original material because it will get lost through decay in time.[88] Elkhuizen adds that the print of Rembrandt's masterpiece is already five years old, but because of the stability of the materiality of the 3D print we know that decay will be less fast than with the canvas and paint

[82] Ex, 1993, pp. 60-64.
[83] Marchesi, 2017, pp. 265-272.
[84] *Ibidem*, 2017, p. 266.
[85] Muñoz Viñas, 2005, pp. 212-214.
[86] Appendix 2. *Interview results,* 2018, pp. 3-6.
[87] Elkhuizen, 2017, pp. 183-187.
[88] Dik, J., *various personal conversations*, 2016-2018.

of Rembrandt's original.[89] The conservation specialists I spoke with suggested that by looking at the 3D print it is possible to examine how Rembrandt's original painting has changed in appearance and it will be possible to draw conclusions about the behavior of the original painting's material.[90] The 3D print would in this sense function as a file report or a time freeze, creating the opportunity for studying and gaining knowledge about the materiality of the original. In Dik's words, this will lead to better technical understanding of material behavior that results in better conservation strategies for the present and the future.[91] In this way *Het Joodse bruidje* would favor the health of the original's materiality and it can help the conservator to meet the contemporary demand of having 'technical sound knowledge' as Muñoz Viñas described.[92]

Something that was not brought up by the people I interviewed, but was suggested by Joris Dik, is that 3D printing can be the tool to visually reconstruct what new material insight reveals.[93] Within the NWO *Science4Arts* project in 2012-2016, Dik led the research project *New light on Rembrandt: through the painted layers,* in which some of Rembrandt's paintings – including *Het Joodse bruidje* - were scanned.[94] This research gave new insight in the pigments used, for instance Dik and his team discovered that Rembrandt used blue tints in his underpaint.[95] Rembrandt specialist Ernst van der Wetering concludes that Rembrandt's techniques and characteristic color scheme were visually different in his time compared to the way his works look today. Moreover, Rembrandt's paintings were often cut in half or were part of a bigger whole of which is known what it must have looked like. [96] In 2015, the Mauritshuis in The Hague used 3D printing to reconstruct *Saul en David* (1660) in its original composition, reuniting the separate parts to become Rembrandt's original painting again.[97] Copying can thus bring the original back to life: the original composition, colors and the artist's intention are saved, leaving the original untouched, but supporting the visualization of the way the original once was. Dik suggests that a 3D print can help visualize this newly found information in materiality without having to interfere with the original. In line with

[89] Elkhuizen, *personal interview*, October 11, 2017.
[90] Appendix 3. *Interview results,* 2018, pp. 3-6.
[91] Dik, J., "Nieuw licht op Rembrandt: door de verflagen heen", *NWO: Science4Arts*, 5 juni 2015, https://www.nwo.nl/onderzoek-en-resultaten/cases/nieuw-licht-op-rembrandt-door-de-verflagen-heen.html (accessed February, 2018).
[92] Muñoz Viñas, 2005, pp. 212-214.
[93] Dik, J., *various personal conversations*, 2016-2018; Appendix 2. *Interview results,* 2018, pp. 3-6.
[94] Dik, 2015, https://www.nwo.nl/onderzoek-en-resultaten/cases/nieuw-licht-op-rembrandt-door-de-verflagen-heen.html (accessed February, 2018).
[95] van Loon, A.; Dik, J., et. al., "Artificial orpiment, a new pigment in Rembrandt's palette", *Heritage Science*, (Berlin: Springer Open, 2017), pp. 2-11.
[96] van de Wetering E; van Eikema Hommes M, "Licht en kleur bij Caravaggio en Rembrandt door de ogen van hun tijdgenoten". *Caravaggio Rembrandt, editor. Exhibition catalogue*. (Zwolle: Waanders/Rijksmuseum Amsterdam, 2006) pp. 164–179.
[97] The 3D reconstruction of *Saul en David* was on display in the *Rembrandt? De zaak van Saul en David* exhibition in het Mauritshuis in The Hague from June 11 until September 13, 2015. The 3D reproduction was – like the reproduction of *Het Joodse bruidje* – created by TU Delft and Océ Technologies B.V. For more information: https://www.mauritshuis.nl/nl-nl/pers/persarchief/2015/mauritshuis-schrijft-schilderij-saul-en-david-toe-aan-rembrandt/ (accessed March, 2018).

Violett-Le-Duc, the original can thus be left in its contemporary colors and composition, but a 3D replication can provide a very accurate visual reconstruction of the painting, Rembrandt and his contemporaries saw when it left the workshop.[98]

From the previously motioned applications of the 3D print, I consider the 3D facsimile as a conservation strategy by means as a useful tool for the documentation of the materiality of Rembrandt's original. However, I want to emphasize in agreement with Marchesi, that a 3D print will and can never fully substitute the original work of art, as it is not created with the same purpose as the original work of art.[99] As Dik explains, the 3D print is and always will be a copy: its purpose is to reveal things that are not possible with the original, rather than functioning as a new version of *Het Joodse bruidje* intended by the artist.[100] Moreover, in agreement with Marchesi's words, reproduction as a form of substitution can only occur under the supervision of the creating artist and because Rembrandt is no longer around, reprinting the work of art cannot completely substitute the original for reproduction will be based on the idea of others from a different time period which will inevitably influence and possibly change the way the original is expressed.[101]

During my research, I presented my remarks and the possibilities to use 3D replication of *Het Joodse bruidje* to the advantage of the original to both museum visitors and professionals. Even though I received some sympathy and heard some understanding of the usefulness of the 3D print as a documentation tool to conserve information, I found it quite remarkable that there was a resistance when I showed participants – especially people working in the art field - a complete one-on-one printed 3D replica of an original work of art. I often got the comment that the replication lacked authenticity and could never replace the original as it was a disgrace compared to the original. It was commented that the possibility to print both texture and visual qualities is suggesting that the original painting by Rembrandt van Rijn is nothing more than just a two-dimensional visual image meant to be mass replicated for a mass public.[102]

What is generally considered as the most alarming fact is the possibility to create paintings by Rembrandt that do not even exist anymore in color or composition. According to Dik, the possibilities 3D printing offers and the material discoveries it reveals – for example the use of blue in his paintings - causes a change in our knowledge of Rembrandt's oeuvre

[98] Dik, 2015, https://www.nwo.nl/onderzoek-en-resultaten/cases/nieuw-licht-op-rembrandt-door-de-verflagen-heen.html (accessed February, 2018).
[99] Marchesi, 2017, pp. 270-271.
[100] Webredactie M&C, September 23, 2013, https://www.tudelft.nl/2013/tu-delft/wetenschappers-maken-3d-prints-van-schilderijen-oude-meesters/, (accessed February, 2018).
[101] Marchesi, 2017, p. 270.
[102] Appendix 3. *Interview results,* 2018, pp. 3-6.

and causes a change in art history.[103] This brings up questions, such as: what happens when the indistinguishable 3D facsimile is placed in the same room next to the original? Which version is more valuable: the 3D print that reveals a correct materiality, or the ‘‘discolored’’ original in the museum? The replica – and the obvious rejection of it – causes a disturbance in the way society perceives the original work of art. The next chapter will identify why the 3D replica is rejected. The answer to this can be found in the value granted to the original, a value that lies in the realm of authenticity for replication changes the contemporary perspective on the twenty-first century idolization of the original connection with the artists of the past.

[103] Dik, 2015, https://www.nwo.nl/onderzoek-en-resultaten/cases/nieuw-licht-op-rembrandt-door-de-verflagen-heen.html (accessed February, 2018).

3. Understanding 3D prints as facsimiles

To understand how the replica and original work of art relate and influence each other, it is necessary to understand how technical reproduction methods were received in the past. Using Walter Benjamin's famous '*Kunstwer*k' essay (1936) as a starting point and relating more contemporary views to this theory will provide a clear understanding of the contemporary reception of the copy in relation to the original. Subsequently, the 3D facsimile will be introduced to see what this technique means to the twenty-first century perception of art.

3.1 Art in the age of technical reproducibility

According to art historian Nicole Ex, art replication is a widely executed and accepted practice: the Romans replicated Greek statues because of their beauty; monks in the Middle Ages spent hours replicating holy books to spread religion and Renaissance painters copied their masters in order to become better painters.[104] Gérard Genette discusses that replicating art in those times was still a time-consuming task that demanded craftsmanship. This would change with the invention of the printing press in the fifteenth century that gave rise to new forms of art, like etching, engraving and lithography. [105] The reproduction of visual images became faster and easier and these inventions mark a change in art creation and appreciation. In her research *Authenticity and Replication* (2012), art historian Rebecca Gordon says that art was no longer made to be a unique piece to be seen by few. The artist became aware that his creation was easily reproducible without a loss of aesthetic quality, enabling to reach a larger public.[106] In the ICOM conference in Shanghai in 2010 curator Rosmarie Beijer-de Haan explained that the existence of multiple editions of one etching did not seem to be an issue to the authenticity of the original artwork and the artist. It was considered a very welcome tool that facilitated the dispersion of art: etchers and engravers not only became able to spread their own creation but also the knowledge about existing paintings and other artworks.[107] In Genette's theory, 3D printing is seen as part of the realm of technical replication for it is like etching rapidly producible without a loss of aesthetic quality.[108]

[104] Ex, N., 1993, pp. 59-61.
[105] Genette,1997, pp. 43-45.
[106] Gordon, R.; Hermens, E.; Lennard, F., 2012, pp. 3-9.
[107] Beier-de Haan, R. "You can always get what you want. History, the original, and the endless opportunities of the copy", *Original, copy, fake, on the significance of the object in history and archaeology museums*, (Paris: ICOM, 2010), pp. 1-4.
[108] Genette, 1997, pp. 47-48, 51-55.

The skepticism towards technical reproduction methods started in the mid-nineteenth century, according to social anthropologist Fiona Cameron. In the spheres of the Industrial Revolution and the augmenting mechanization that came with it, photography introduced itself in the world of art. Cameron says it was no longer necessary to dedicate a lifetime of training to become a skilled artist and spend hours painting, sculpting or drawing in order to depict reality for it is now possible to capture reality even more accurately than a painter would be capable of by one simple click of a button.[109] Even though photography was still far removed from the quality it has today, the fact that works of art could be replicated with such little effort prompted a lot of discussions, of which German philosopher Walter Benjamin (1892-1940) is one of the key influencers. Living in a time when photography started to become more accurate and frequently used, Benjamin saw how technical reproducibility was becoming an unstoppable phenomenon that would change the way we view art.[110] In Benjamin's theory, *Het Joodse bruidje* as a technical reproduction would lack a connection with the past and a unique functionality. The latter is what creates an intimate bond between the work of art and the viewer that Benjamin refers to as the 'aura'.[111] In Benjamin's words, a 3D print's new non-traditional materiality is not the only cause of the deficit of aura. It is also caused because of the possibility to show both the visual qualities of Rembrandt's painting, as well as its materiality everywhere in an instant. Benjamin describes this as the transformation from *cult value* - the uniqueness of the image of the original that was constructed through tradition - to *exhibition value* – being appreciated as valuable because society decides so. Subsequently Benjamin adds that this reproducibility creates a shift in the reception of the work of art: at the time of creation, *Het Joodse bruidje* was meant to be seen by only a few. Thus, in Benjamin's words, technical reproducibility creates availability of art to a mass audience.[112]

Another change Benjamin notices besides the shift from uniqueness to plurality and from exclusivity to accessibility, is the change from art made within a tradition and with a defined ritual or functional purpose to *art for art's sake.*[113] Rembrandt's painting was made for the commissioner who depicted himself as the protagonist in the Biblical love story of Isaac and Rebecca. According to Benjamin, due to technical reproduction, it is transformed into nothing more than a famous picture of Rembrandt's oeuvre. The painting is no longer valued for its connection with the past and its artistic quality, but more because it is

[109] Cameron, F., "Beyond the cult of the replicant: museums and historical digital objects – traditional concerns, new discourses", *Theorizing digital cultural heritage: a critical discourse*, Cambridge (MA): MIT, 2007, pp. 53-56.
[110] Benjamin, 1936, pp. 6-9.
[111] *Ibidem*, pp. 14-18.
[112] *Ibidem*, pp. 40-42.
[113] *Ibidem*, pp. 14-16.

aesthetically pleasing to the majority of the mass public, losing its original purpose and function and thus, as Benjamin says, its aura.[114]

In Benjamin's view Rembrandt's paintings were never made to be mass reproducible so how can – in this case the 3D replication of *Het Joodse bruidje* – lacking aura in materiality and function - ever be useful and acceptable?[115] Benjamin admits that technical reproducibility does not only have negative influences on the original. [116] In the case of the 3D print, it can go to places where the original would never survive due to an unsafe environment. 3D replication would thus make it possible to relocate and demonstrate *Het Joodse bruidje* in the original candlelit seventeenth-century setting it was created in. French philosopher Bruno Latour explains that in this sense Benjamin suggests that a replica, in this case a 3D print, cannot help the original painting to maintain its aura, but can be a useful to keep the aura of the setting in time in which the original was created.[117]

This automatically implies another way in which Benjamin would demonstrate 3D print to be a welcome invention: technical reproducibility can reveal what we were never able to see before. What Benjamin means is that technical reproduction creates the possibility to choose what we want to make visible and what we want to remain undiscovered.[118] Benjamin suggests that replication creates new opportunities and provides us with new information about *Het Joodse bruidje* in a former state, without color and material decay, which is mentioned by Dik and Elkhuizen as stated in the previous chapter. This is not possible with the original work of art without having to irreversibly restore, or even damage it. Revealing the information hidden in the original material would thus strengthen the connection between art and science, which in Benjamin's belief is something that can be beneficial to the state of the original work of art.[119]

Even though it is almost a century ago since Benjamin published his theory, in my fieldwork I discovered that his theory is still considered as an important theory on technical reproduction.[120] However, 3D printing is a replication method Benjamin would never have imagined possible. It is therefore important to see if 3D replication and our view on copying is indeed still compliant to Benjamin's beliefs or whether we have moved past his assumption into a different society: a society in which technical replication is not seen as such a big threat to the aura of the original as Benjamin thought.

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[114] Benjamin, 1936, pp. 18-22.
[115] Walter Benjamin states on page 6 that art has always been reproducible, but never technically reproducible without the touch of an artist. In this sense he admits that art may be reproduced.
[116] Benjamin, 1936, pp. 40-44.
[117] Latour, B.; Lowe, A., "The migration of the aura and how to explore the original through its facsimiles", *Switching Codes,* (Chicago: University of Chicago, 2011), pp. 285-287
[118] Benjamin, 1936, pp. 40-42.
[119] *Ibidem*, 1936, pp. 42-50.
[120] Appendix 3. *Interview results,* 2018, pp. 3-6.

3.2 The increasing romanticization of authenticity in the age of the copy

In *Counterfeit art: Authentic fakes?* (1992) historian David Lowenthal argues that with the augmenting interest in the authentic comes an automatic rejection of art forgery: originality and counterfeit are inextricably intertwined.[121] In his critical overview on the discourse of copying in his book *Art Forgery: The History of a Modern Obsession* (2011) philosopher Thierry Lenain describes - in line with Lowenthal - that authenticity is something that has gained more ground over the last decades: on the basis of the amount of articles and theories on the concept one might say that contemporary society became more or less obsessed with it.[122] Lowenthal, Lenain, Ex and others reflect upon what authenticity is and why it gained so much importance in the years after Benjamin published his theory. Moreover, why do people react so reserved towards facsimiles?

Authenticity is regarded as something that has the quality of being authentic: it refers to something that is genuinely made or done in a traditional way that faithfully resembles an original based on *accurate* and *reliable* facts.[123] The facts in which people consider to find 'genuine' information about the artist, his oeuvre and work of art are complex, peculiar and, as Ex says, it is a phenomenon that shifts over time.[124] According to historian Sîan Jones, who did practical research on the reception of authenticity, this shift can be linked and traced back to the changing relationships of the individual (artist) in society, due to scientific reason and the materialistic approach of revealing the truth as we have briefly seen in the previous chapter and on which this chapter will elaborate.[125]

The contemporary fixation on the authenticity and tradition of an object, Lenain argues, is due to the increased interest in the individual, albeit related to personal individuality or that of the artist as the genius. From Jones' perspective, the experience of the singular object or individual people is something that is not new for it has occurred in every period in history, but in different intensities and implementations.[126] The intensity and presence of the individual artwork has also influenced the quantity and interpretation of art forgery.[127] Going back in time, Lenain and Jones explain that in the Middle Ages authenticity was understood as a collective phenomenon: the church decided whether or not something was authentic, and authenticity did not depend on its material origin but lays within the *cult*

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[121] Lowenthal, D., "Counterfeit art: authentic fakes?", *International Journal of Cultural Property*, (Cambridge: Cambridge University, 1 (1992) 1), pp. 125-127.
[122] Lenain, 2011, pp. 1-10.
[123] Oxford Dictionaries: https://en.oxforddictionaries.com/ (accessed March, 2018).
[124] Ex, 1993, pp. 59-64.
[125] Jones, S., "Negotiating authentic objects and authentic selves: beyond the deconstruction of authenticity", *Journal of material culture*, (London: University College London, 15 (2010) 2), pp. 186-187.
[126] Lenain, 2011, pp. 1-10.
[127] *Ibidem.*

value of the object's connection to the supernatural.[128] Lenain adds that there was no interest for the value of an object in tradition and no need for a connection with our ancestors: art was made in favor of what God wanted right here, right now.[129] This implies that the meaning of art was not bound to craftsmanship and materiality: the motivation for copying relics and why replication was not seen as art forgery or a crime because the copy allowed the possibility to protect the genuine sacral power of the original object by creating a second 'body' for it, as Jones explains.[130] For Lenain, in this sense, the copy takes over the immeasurable supernatural power of a God that was embedded in the object that was originally said to have it.[131] In Jones' vision, at this period in time, the artist was not an individual who signed his work in order to spread his or her own name: art was made by the *community* - a cluster of anonymous people with a wide variety of skills - for the *same collective* belief in a higher good.[132] For example, Rembrandt himself often constructed his artworks with the aid of his pupils.[133] Lowenthal confirms that tradition was not embedded in the uniqueness of an object and the hand of the artist that created it, which would allow the 3D replication of *Het Joodse bruidje* to exist for it can acquire the original's aura.[134] Even though authenticity was something collective and copying was not forbidden, Lenain argues that it marks the beginning of the 'spiritual' value – or what Benjamin refers to as the 'aura' - the modern Western society relates to art.[135]

French philosopher René Descartes' (1596-1650) quote *cogito ergo sum* (I know, therefore I am) is seen as marking the shifting philosophy that validity is measurable, personal and based on facts.[136] Lenain explains that this meant an increase of the idea that the immeasurable spiritual integrity or authenticity of the work of art is solely embedded in the scientifically provable qualities of an object: its paint, Rembrandt's impasto and the canvas.[137] The way people view Rembrandt's painting has changed from something that is plural, immeasurable and quantitative, to something that is singular, measurable and qualitative. Thus, in Lenain's words, aura is immanent to only the original painting itself and this connection cannot be passed on to the visually indistinguishable 3D print.[138]

Lowenthal argues that Western society today is still fixed on the *ego*: the belief that authenticity is something that is *unique* to every individual and the only way to encounter

[128] Lenain, 2011, pp. 1-10; Jones, 2010, pp. 186 – 187.
[129] *Ibidem*, pp. 74-76.
[130] Jones, 2012, pp. 186-188.
[131] Lenain, 2011, p. 90.
[132] Jones, 2010, pp. 187-188.
[133] van de Weteringen, E., *Rembrandt: the painter at work,* (Amsterdam: Amsterdam University, 1997), pp. 80-82
[134] Lowenthal, 1992, pp. 90-91.
[135] Lenain, 2011, pp. 148-149.
[136] *Cogito ergo sum* can be found in René Descartes' *Discours de la Méthode* (1639), a book that argues that the truth can only be found in science.
[137] Lenain, 2011, pp. 164-167.
[138] *Ibidem*, pp. 166-167.

aura, is in an *original* work of art that is made of a *unique* composition of materials that is characteristic of *one fixed moment* in time and was skillfully crafted by the *autonomous* genius.[139]

According to Latour, humanity is nowadays more familiar with technical reproducibility than Benjamin was at the time. Technical replications of Rembrandt's painting are embraced in a way that is harmonious with the original. They are used everywhere: on the Internet, printed in catalogues, or on tourist miscellanea.[140] Remarkable is the fact that the desire to see the original has not decreased as Benjamin suggested. According to statistics on museum visits in the Netherlands provided by the Museum Association (*Museum Vereniging*), it is clear that the contrary is happening: the longing to see the original and feel its aura has noticeably grown over the years even though technical replication of art has increased.[141] Moreover, concluding from the various art exhibitions I have visited, technical reproduction methods are used more frequently in exhibiting art and, in a sense, to conserve art. An example is the *Nineveh* exhibition held in het National Museum of Antiquities in Leiden where replications and reproductions of lost artifacts were displayed in the same room as the originals.[142] *The Making of Modern Art* exhibition at the van Abbemuseum in Eindhoven, which shows more replicas than original works of art for it could not loan various artworks and to address whether or not a replica can be a substitute for the missing paintings, is another example.[143] The use of replications in the exhibition of art to conserve art may suggest that our perception of replicas has changed considerably since Benjamin published his work. Has technical reproduction indeed become more acceptable?

The people I interviewed during my fieldwork admitted that art replication through technical methods like photography is a common practice that is unstoppable and part of contemporary society.[144] Even though technical replication is more commonly used, it is noticeable that the prevailing opinion about copies has remained the same: in Marchesi's words, the 3D replica is still the less valued aura-lacking version of the original.[145] This resistance towards the copy suggests that the twenty-first century thinking is still in line with Benjamin's prediction. However, Ex remarks that there is an important shift that Benjamin has not foreseen: because of the familiarity with fakes and (digital) copies that surround and

[139] Lowenthal, 1992, pp. 81-82.
[140] Latour, Lowe, 2011, pp. 287-289.
[141] Between 2011 and 2016 we can see an increase of more than 50% museum visits in the Netherlands (21.1 million versus 31.7 million). For more detailed information: https://www.museumvereniging.nl/museumcijfers-2016 (accessed March, 2018).
[142] *Nineveh – Art of an Ancient Empire* exhibition ran from October 20, 2017 until March 26, 2018. The exhibition consisted of various reproductions of fragments of (lost) Assyrian monuments and replicas of archaeological objects of the British Museum.
[143] *The Making of Modern Art* exhibition ran from April 26, 2017 until January 2, 2018. The exhibition shows various copies of modern artworks in order to discuss the creation of modern art and how the copy has a role in this process.
[144] Appendix 3. *Interview results,* 2018, pp. 3-6.
[145] Marchesi, 2017, pp. 55-56.

confront the twenty-first century society everywhere on a daily basis, people have become even more obsessed with the original and the connection with history through the aura of the original.[146] It can be concluded that the existence of copies contradicts the loss of aura of the original Benjamin predicted, since the opposite is happening. The contemporary stance on the acceptance towards the replication is what Marchesi and Ex refer to as a *conditio sine qua non*: appreciation of the aura of the original would not be of such importance if there was not something that threatens it.[147] As philosopher Jos de Mul says in *The Work of Art in the Age of Digital Recombination* (2009), the 3D print of *Het Joodse bruidje* is both the friend and foe of the original: on the one hand, the print is needed to learn more about the original and to increase the longing for the authenticity of the original, but on the other hand, the copy is rejected for it can never be a replacement of Rembrandt's painting.[148]

The contradicting contemporary view on replication generates the question if the 3D facsimile of *Het Joodse bruidje* will ever be accepted. The fixation and the romanticized connection with the past embedded in art's materiality have resulted in an obsession of keeping the material authenticity of the original work of art intact, resulting in the creation of the copy, as Lenain puts it.[149] What is worth contemplating is whether the obsession with the material authenticity of the original will lead to a point where society rather sees nothing than a copy. However, art historian Margaret Iversen argues in *Resistance towards the copy* (2007) that in the twenty-first century society that is used to the existence of *art for art's sake*, works of art made of non-durable materials and the dependence on digitally generated images and files, it would be superficial to say that validity of the original is still solely based on materiality.[150] Keeping Mul's statement in mind, it is necessary to understand what happens to the authenticity of the original when an indistinguishable 3D facsimile will l be placed next to the original in the context of different authenticities granted to the original.

[146] Ex, 1993, 61-64.
[147] Marchesi, 2017, p. 53; Ex, 1993, 56-57.
[148] de Mul, J., "The work of art in the age of digital recombination", *Digital material: tracing new media in everyday life and technology*, (Amsterdam: Amsterdam University, 2009), pp. 96-99.
[149] Lenain, 2011, pp. 241-252.
[150] Iversen, M., "Resistance to replication", *Tate Papers*, (London: Tate, 8 (2007)), http://www.tate.org.uk/research/publications/tate-papers/08/resistance-to-replication (accessed April, 2018)

4. The 3D facsimile in relation to its original

This chapter explores the various 'authenticities' that can be granted to the original work of art nowadays. By placing the original in the context of different 'authenticities', it will become clear how the 3D replica and the original function in relation to each other.

4.1 Authenticities

In the *Tate Papers* of 2007 conservator Sebastiano Barassi - as well as Nicole Ex in her book - mentions that in an age in which replication methods improve and are omnipresent, German art historian Alois Riegl's theory (1901) still provides a useful framework.[151] Barassi mentions that Riegl describes works of art as 'monuments': artifacts that have a connection with the past. He describes this phenomenon as "age value".[152] According to Riegl the monument also has a ""memory value"": a value that in a way satisfies humanity's social, psychological and intellectual needs.[153] Thus Barassi emphasizes that Riegl's definition of the monument is more or less applicable to every object that is the result of human activity.

Ex and Lowenthal recognize varieties of authenticity - or *"*memory value*"s* in Riegl's words - contemporary society grants to *Het Joodse bruidje* today: functional, conceptual, and material authenticity.[154] According to Ex, functional authenticity prefers the safeguarding of the original function of the object.[155] Lowenthal adds that this form of authenticity holds a mania for showing things only in the environment that properly belongs to them.[156] Conceptual authenticity favors the return to the intention of the artist, as Lowenthal and Ex describe. Ex adds that this phenomenon is something that is often more applicable for contemporary art for these artworks are more often meant to be conceptual and appreciated because of the artist's message over its materiality. In contrast to Lowenthal, Ex adds a-historicity and historicity as extra authenticities that I consider worth mentioning in relation to the explanation of conceptual authenticity further on as it correlates with the latter.[157] Lastly, material authenticities validity lies in the belief that the materiality of the work of art provides the most legitimate connection with history and the artist, as Ex says.[158] The

[151] Barassi, S., "The modern cult of replicas: A Rieglian analysis of values in replication", *Tate Papers*, (London: Tate, 8 (2007)), http://www.tate.org.uk/research/publications/tate-papers/08/the-modern-cult-of-replicas-a-rieglian-analysis-of-values-in-replication (accessed April, 2018)
[152] Riegl, A., *Der moderne Denkmalkultus, seine Wesen und seine Entstehung*, (Vienna: K.K. Zentral-Kommission für Kunst-und Historische Denkmale,1901), pp. 23-49
[153] Barassi, 2007.
[154] Ex, 1993, pp. 93-96; Lowenthal, 1992, pp. 82-85.
[155] Ex, 1993, pp. 111-113.
[156] Lowenthal, 1992, p. 83.
[157] Ex, 1993, p. 94.
[158] *Ibidem*, pp. 96-97.

interviews that I conducted will be related to Riegl's "memory value"s and Ex's and Lowenthal's theories, to make these different authenticities more up-to-date. This will make it possible to analyze which ethical and moral issues arise in relation to the authenticity of *Het Joodse bruidje* when introducing an indistinguishable 3D print.

4.2 The contemporary relation between original and 3D facsimile

Functional authenticity is the first authenticity I want to mention because the interviews revealed that it was considered the least applicable authenticity for *Het Joodse bruidje* and therefor considered the least damaging.[159] Lowenthal, Latour and Lowe mention that it is important to keep in mind that even though *Het Joodse bruidje* is not necessarily an object that is directly handled, it becomes autonomous for it is detracted of any context or functional purpose when it is displayed in a museum.[160] However, the ones interviewed reacted to Lowenthal that contrary to sculpture or ethnographic objects that were made to be held and touched, *Het Joodse bruidje* is a painting and is not appreciated because of its functional value but because it has autonomous aesthetic or material value. This apparent lack of importance of the functional authenticity of Rembrandt's painting in the artist's studio, leads to a more accepting attitude towards the 3D facsimile. The ones interviewed suggested that to recreate the original environment *Het Joodse bruidje* was painted in, a 3D printed substitute would be promoted if the original was safeguarded in the museum.[161] So, in this case the 3D print is not considered to be a threat to authenticity or the meaning of the original for there is – literally and figuratively speaking – enough distance between original and print.[162]

However, in contrast to Lowenthal's and the interviewees' initial idea of the limited functional authenticity of the painting, I argue that the 3D print contests the functional authenticity granted to the original.[163] An example was executed in *Museo del Prado* in Madrid's *Touching the Prado* exhibition in 2015, which experimented with 3D printing to add the experience of touch to paintings (Img. 7). Curator of the exhibition Fernando Pérez argues that the 3D print will not only grant the painting a visual authenticity but also a tactile one: touching Rembrandt's heavy brushstrokes will grant the viewer a better understanding of how Rembrandt created depth. The ease and accuracy with which full-size visual and of textural replication of Rembrandt's original can be printed and the durability of the replica's

[159] Appendix 3. *Interview results,* 2018, pp. 3-6.
[160] Lowenthal, 1992, p. 84; Latour; Lowe, 2011, pp. 276-277.
[161] Appendix 3. *Interview results,* 2018, pp. 3-6.
[162] *Ibidem.*
[163] Lowenthal, 1992, p. 84.

materiality causes the distance between original and copy to narrow, providing the painting an extra functional purpose.[164]

Nevertheless, the Dutch professionals reacted doubtful towards this idea. Although 3D printing offers the possibility of touch, which creates new educational possibilities and a better understanding of Rembrandt's painting technique, it changes the way the original *Het Joodse bruidje* is perceived for it is no longer a flat two-dimensional object that should be admired from a distance. The latter confirms Benjamin's prediction of the loss of aura caused by technical reproduction: there is a shift from the religious *cult value* of the original to an *exhibition value*, as 3D printing changes the painting's original purpose.[165] It becomes a three-dimensional object that provokes direct engagement.[166]

To go further, Barassi argues that 3D printing would be almost as damaging to the original as iconoclasm: the opportunity to touch the 3D print of Rembrandt's painting will provoke touching the original if the average visitor is not informed correctly. This could endanger the object's conceptual and material authenticity contemporary society favors most.[167] The interviewees remarked that the addition of touch is a forced functionality that 3D printing grants to the works of art for Rembrandt never intended *Het Joodse bruidje* to be touched, so it would contest Rembrandt's conceptual idea.[168]

As Ex says and the interviewed professionals and museum visitors demonstrate, conceptual authenticity is not only granted to conceptual artists as Rembrandt is praised for his characteristic impastos and dark but expressive colors.[169] However, Lowenthal argues that a conceptual appreciation in the case of *Het Joodse bruidje* is more complex than in the case of contemporary art: to know Rembrandt's intent is impossible for he passed away a long time ago. He adds to this that in the case of Rembrandt's painting, it is the contemporaries' taste and belief that decide what is considered as the authentic look that coincides with the myth of the artist.[170] Ex adds to this that what is considered as the conceptual authenticity depends on the importance granted to the history of a painting, which she refers to as a-historic or historic authenticity. Historical authenticity is somewhat in line with Ruskin and can be considered a form of documentation for it allows traces and some decay and *patina* as a

[164] *Touching the Prado (Hoy toca el Prado)* in El Museo del Prado in Madrid was an exhibition that exhibited 3D facsimiles of various paintings in the collection and invited the visitor to touch the works of art. The exhibition was held from January 20th, 2015 – October 18th, 2015. For more information: https://www.museodelprado.es/actualidad/exposicion/hoy-toca-el-prado/57e57898-87eb-4aa6-8b0f-4876a6298125 (accessed April, 2018).
[165] Benjamin, 1993, pp. 18-22.
[166] Appendix 3. *Interview results,* 2018, pp. 3-6.
[167] Barassi, 2007.
[168] Appendix 3. *Interview results,* 2018, pp. 3-6.
[169] *Ibidem*, pp. 106-107.
[170] Lowenthal, 1992, p. 84.

proof of the historical events the object has gone through.[171] In contrast, a-historic authenticity prefers the way the painting was when it left the artist's workshop and thus prefers Violett Le-Duc's 'pristine state' over a worn appearance.[172] So the more a-historic authenticity is granted, the closer the painting gets to the concept of the artist. Reflecting Ex's terms of historical and a-historical authenticity elucidates that contemporary society is mainly in favor of a historical conceptual authenticity. This means that the material state of *Het Joodse bruidje* is conserved to a point of history that today's society considers authentic.[173] In line with Ex I suggest that this outlook ignores that decay or disruptions by previous restorations have altered the way the painting initially looked like and was truly conform to what Rembrandt intended to express.[174] In addition to this stance, Lowenthal argues that contemporary society is superficial in the sense that the façade of the painting is what is considered to be the 'real' thing.[175]

Bringing the 3D replica of *Het Joodse bruidje* into this discussion reveals that the facsimile is conform to what contemporary society considers as Rembrandt's historical concept. The replica is a one-to-one copy of what Rembrandt's original looks like today including the material and visual traces of time. This indicates that the existence of the 3D print would do no harm to the conceptual authenticity of the original. Nevertheless, the way in which the interviewed professionals consider the 3D print as harmful to the conceptual authenticity of the original – more than previous technical reproduction methods – is that 3D printing allows to replicate Rembrandt's characteristic impasto and characteristic color scheme that took him years of artistic training to develop at a speed of under eight hours in polycarbonate.[176] Latour and Lowe argue that the rejection of the 3D print is mainly due to the feeling of 'unequal treatment': the idea exists that the creation of the 3D replica costs little effort in comparison with the original.[177] In addition to Latour and Lowe and in line with Lenain, the interviewees mentioned that the 3D print denies the importance of the history that led Rembrandt to the creation of his concept and his choice of material to express his ideas, making the existence of the artist and even the skilled copyist obsolete: nobody can come close to copying with the accuracy of the 3D printer.[178] However, Rembrandt specialist Ernst van de Wetering contradicts this idea. He argues that Rembrandt himself was in favor of replication and spreading his oeuvre and artistic knowledge.[179] In the Dutch newspaper *De*

[171] Lowenthal, 1992, pp. 120-122.
[172] Ex, 1993, pp. 115, 120.
[173] Appendix 3. *Interview results,* 2018, pp. 3-6.
[174] Ex, 1993, pp. 108-109.
[175] Lowenthal, 1992, p. 92.
[176] Appendix 3. *Interview results,* 2018, pp. 3-6.
[177] Latour; Lowe, 2011, pp. 280-283.
[178] Lenain, 2011, pp. 311-317.
[179] van de Weteringen, E., (1997), pp. 80-82.

Volkskrant he says that the 3D replica is more conceptually conform to what Rembrandt intended.[180]

The interviews clarified that Rembrandt's acceptance towards copying is ignored for Benjamin's aura and the fetishized isolation of the materiality of the autonomous work is enforced in contemporary museums, which Ex and Lowenthal refer to as material authenticity.[181] As Cameron explains, the museum's object-centered approach decides that society should seek value, aura and originality of the painting in its materiality.[182] This leads to the rejection of the 3D print as a replacement of the original. In line with Cameron, their argument is that - in a society that is constantly surrounded by replicas - the museum is supposed to be the place that safeguards the authenticity of Rembrandt's painting and should only provide the public with the 'genuine' painting.[183] As the Dutch professionals remark, the potential danger of placing the 3D print in a museum is that the museum works as a catalyst for the authentication of objects.[184] In *Thoughts on thoughts on replication* (2007) conservator Harry Cooper enforces the idea of the professionals as he emphasizes that when the replica is displayed in the same setting as the original, it has the ability to easily assume all the powers of the original, especially when the artwork's usual setting is in the museum.[185]

Another reason the 3D print is considered a threat in terms of material authenticity is provided by Lenain as he argues that it is the quality of the replica that makes absorption of the aura of the original easier.[186] Moreover, in the context of art historian Heide Skowranek's article in the *Tate Papers* (2007) the 3D replica of *Het Joodse bruidje* shows patina of time despite the newness of materiality and it validates a connection with history, which makes the print more convincing and possibly more threatening.[187] In *The Culture of the Copy: Striking likeness, unreasonable facsimiles* (1996) historian Hillel Schwartz describes that in today's *cult of the copy* the technical reproduction – in this case the 3D print - feels like art forgery, and not like a mere copy, "(…) because it is passed off in the same name or style of another person or era."[188] In my opinion the latter is similar to Lowe's and Latour's previously

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[180] van de Weteringen citated in van Zeil, W., "Interessante plaatjes"*, De Volkskrant*, August 14, 2009, https://www.volkskrant.nl/cultuur-media/interessante-plaatjes~b6cc56c9/ (accessed April, 2018)
[181] Appendix 3. *Interview results,* 2018, pp. 3-6; Ex, 1993, pp. 121-123; Lowenthal, 1992, pp. 92-93.
[182] Cameron, 2007, pp. 51-52.
[183] Appendix 3. *Interview results,* 2018, pp. 3-6.
[184] *Ibidem.*
[185] Cooper, H., "Thoughts on thoughts on replication", *Tate Papers*, (London: Tate, 8 (2007)), http://www.tate.org.uk/research/publications/tate-papers/08/thoughts-on-thoughts-on-replication (accessed April, 2018).
[186] Lenain, 2011, pp. 311-317.
[187] Skowranek, "Should we reproduce the beauty of decay? A *Museumsleben* in the work of Dieter Roth", *Tate Papers*, (London: Tate, 8 (2007)), http://www.tate.org.uk/research/publications/tate-papers/08/should-we-reproduce-the-beauty-of-decay-a-museumsleben-in-the-work-of-dieter-roth (accessed April, 2018).
[188] Schwartz, 1996, p. 182.

mentioned unequal treatment for the 3D print does not take as much time to manufacture as the original and is not created with similar materials in the same setting in history. In the view of the Dutch professionals, the idea 3D printing creates is that *Het Joodse bruidje* is a two-dimensional image that can be reproduced everywhere, ignoring the concept of the artist and degrading Rembrandt's unique painting into a tradeable commodity that no longer has any significance in history.[189] So unlike copies made by Rembrandt's pupils, this method of copying seems more harmful to Rembrandt as an artist.[190]

Schwartz adds that another reason for rejecting 3D print from the perspective of material authenticity comes from the fear of 'incorrect transcription', leading to deceit and false information.[191] Confirmed by the professionals, '3D forgery' has the possibility to provide an incorrect truth about the original: the copy is not of the same materiality and the technology is not yet advanced enough to flawlessly replicate Rembrandt's painting. Especially presenting the 3D print in a museum setting amongst original paintings is considered to be dangerous.[192] However, Lenain argues that if someone were to do scientific research or to take the small effort of just touching the work of art, one would immediately know that it is a replica.[193] Nevertheless, the Dutch professionals believe that the average visitor - and even they themselves - will not be able to distinguish the 3D copy from the original if it is presented as a work of art. The professionals argue that when an inaccurate 3D print is presented in a museum setting, the average visitor will be deceived and provided with false information.[194] Moreover, the visitor will come to believe that the incorrect 3D printed version of *Het Joodse bruidje* is the original painting, which would damage the perception with which the original is received for it was not made of the same material and colors as the print. This can potentially harm the original's aura and it can change the value granted to Rembrandt's oeuvre.[195]

Moreover, Cameron highlights that this replication method in combination with the current ease with which everything can be shared and spread virtually, Rembrandt's painting – which possibly includes false information - can be recreated and framed anywhere.[196] Cooper explains that this entails that the 3D print can assume the original's aura or obtain its own aura because the original is not present.[197] As Cameron says, the plural existence of *Het Joodse bruidje* forms the idea that the importance of the connection with the artist,

[189] Schwartz, 1996, p. 182.
[190] Latour; Lowe, 2011, pp. 281-282
[191] Schwartz, 1996, pp. 194-197.
[192] Cameron, 2007, pp. 51-52, 66, 69.
[193] Lenain, 2011, pp. 241-252.
[194] Appendix 3. *Interview results,* 2018, pp. 3-6.
[195] *Ibidem.*
[196] Cameron, 2007, pp. 50-52; Appendix 2. *Interview results,* 2018, pp. 3-6.
[197] Cooper, 2007.

history and the creative thought needed to make art is denied and would thus reject (material) art history, making museums obsolete.[198]

However, Barassi, in agreement with Cameron, argues that the replica should not be seen as a threat to the original's materiality: it is the copy - in this case the 3D facsimile - that spreads cultural heritage and records the knowledge that is needed to save the materiality of the original.[199] As Rembrandt himself would have desired and as Schwartz already argued in 1996, it is repetition that creates awareness of the original, copying that causes familiarity and facsimilation that conserves the objects that compile what society is.[200] The realization that 3D replication should not be seen as a threat to the material authenticity of the original, but should be considered as a documentation tool in favor of the original, is admitted by the Dutch professionals.[201] An example of this is the exhibition *The Girl in the Spotlight* in het Mauritshuis in The Hague in 2018. A 3D print made by TU Delft was placed near the original that was blocked by machines due to material research.[202] Visiting the exhibition and asking the public confirmed that the 3D facsimile was considered advantageous to the authenticity and the 'auratic' bond with the original: the replica provided the viewer with the aesthetic quality and the concept of Vermeer's original but the original in the room provided the aura. In line with what Barassi and the Dutch professionals believe there was no confusion possible between which one was the original or the copy (Img. 8). This proved that copy and original could harmoniously interact in the same space.[203]

I want to emphasize that the 3D prints in the case of *Het meisje met de parel* and *Het Joodse bruidje* still depend on the original's aura. However, Barassi remarks that some consideration should be given to the life of the replica in the years after its creation.[204] In the course of time, it does happen that replicas become authentic on their own and obtain their own aura, like for example the earlier mentioned *Lascaux II*. This 'authentication' allows the replica to exist on its own without the connection with the original, implying that there is a possibility that multiple authentic versions of *Het Joodse bruidje* can exist. Since it has already been five years since *Het Joodse bruidje* was printed, it is necessary to explore what the aging of the 3D replica of *Het Joodse bruidje* does, not only to the replica itself, but also to the authenticity of the original.

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[198] Cooper, 2007.
[199] Cameron, 2007, pp. 54-55; Barassi, 2007.
[200] Schwartz, 1996, pp. 237-239.
[201] Appendix 3. *Interview results,* 2018, pp. 3-6.
[202] *The Girl in the Spotlig*ht was a material research project lead by painting conservator Abbie Vandivere in which Vermeer's *Het meisje met de parel* was examined with the newest technological inventions. The research project was executed publicly in the Golden Room of the Mauritshuis between February 26, 2018 – March 11, 2018. For more information: https://www.mauritshuis.nl/en/discover/exhibitions/the-girl-in-the-spotlight/ (accessed April, 2018).
[203] Appendix 5. *Interview results The Girl in the Spotlight.*
[204] Barassi, 2007.

5. The 3D facsimile on the long term

The 3D print has proven to prompt moral and ethical discussions when it is placed in relation with the original it was derived from. However, it is not solely the original that ages, but also its replica. This chapter will look at the replica regarding the future and tries to answer the question whether the 3D print itself can become authentic. I will discuss what the authentication of the 3D facsimile means for the 3D print itself and what it means for the original. Subsequently, this chapter will return to the topic this thesis started with for it will be discussed whether or not the 3D replica itself can function as a conservation strategy for an authentic 3D replica.

5.1 The authentication of the 3D replication

Reflecting on Barassi's words and the conclusions of the past chapters, in the twenty-first century *Het Joodse bruidje* is valued for its unique material quality that provides the connection with humanity's past and provides a tactile connection with Rembrandt's concept.[205] However, Schwartz remarks that as time passes it is not just the original work of art that ages and forms a bond with the past, but so does the replica. In this sense, Schwartz suggests that the facsimile itself can become original.[206] Ex confirms Schwartz' assumption by saying that although society may be resistant towards the facsimile, history has proven that copies *can* become acceptable and authentic. This has happened, for example, to the copy of Michelangelo's *David* in front of the Palazzo Vecchio or the previously mentioned *Lascaux II* which became a historical monument.[207] Both replicas have shifted from fulfilling a functional purpose in favor of the material authenticity of the original, to autonomously authentic objects. When explaining how and under which conditions the authentication of the 3D replication can happen I want to emphasize that it is important to keep in mind that there is a significant difference between the original and the print: the original is considered to be a work of art for it was made with that purpose, whereas the 3D print is never meant to be a unique artwork. In realizing what the authentication of the 3D replication means to the print itself and how this influences Rembrandt's original, it is therefore necessary to make a distinction between the unique existence of the 3D facsimile in its own 'realm' of 3D printing versus the authentication of the print as a replication of Rembrandt's original.

[205] Barassi, 2007.
[206] Schwartz, 1996, pp. 231-232.
[207] Ex, 1993, pp. 60-62.

The authentication of the 3D facsimile as a 3D print

Considering the 3D replication of *Het Joodse bruidje* solely as a product of 3D printing technology, Cameron explains that the 3D print becomes authentic for it is a unique object with its own aesthetic and material qualities.[208] Elaborating on the latter from Alois Riegl's perspective, the copy becomes a 'monument' for it will obtain "age value" simply because it survives the passage of time.[209] In the context of Cameron's words and Riegl's "age value", it can be argued that the 3D print of *Het Joodse bruidje* functions as historical proof of what 3D printing technology was capable of in 2013. Moreover, Barassi argues in the context of Riegl's theory that the authentic copy can also be granted *"*memory value*"* next to its gradually developing "age value". The aging of the 3D print demonstrates a bond with acts of humanity in an earlier moment in time for the 3D facsimile of *Het Joodse bruidje* demonstrates the exploration of the possibility of 3D printing fine art in 2013. [210] In agreement with Barassi, de Mul elaborates on the latter from Benjamin's perspective of *cult value*: the print symbolizes a uniqueness for it is one of the limited number of copies existing that expresses and represents a cultural development of contemporary society.[211]

Moreover, placing the 3D print in the context of Ex's and Lowenthal's authenticities and Riegl's "memory value", the possibility of touching the 3D print – like in the *Touching the Prado* exhibition – allows the replica to obtain its own functional authenticity to the individuals that grant high value to the functional purpose of the artwork[212] As the interviewed museum visitors say, to blind or partially sighted people or children, the functional purposes of the 3D print will provide a more valuable bond with the work of art and a deeper – literally – tangible understanding than the painting's visual or conceptual qualities can provide them.[213] In line with Ex's and Lowenthal's description of functional authenticity, Schwartz describes that the aged facsimile of *Het Joodse bruidje* becomes an 'auratic copy' for it symbolizes a unique bond between object and person, in which it has become the carrier – or a relic - of a cultural cult that worships the experience of touch.[214]

The authentication of the 3D facsimile as a copy of an original

However, Barassi emphasizes that the possibility of this particular 3D print becoming authentic is not solely based on its autonomous self: the 3D facsimile is still and will always

[208] Cameron, 2007, pp. 64-65.
[209] Riegl, 1901, pp. 23-29.
[210] Barassi, 2007.
[211] Mul, 2009, pp. 99-104.
[212] Ex, 1993, pp. 59-64.
[213] Appendix 3. *Interview results,* 2018, pp. 3-6.
[214] Schwartz, 1996, pp. 226-229.

be a copy of Rembrandt's original.[215] Taking the inseparable bond with Rembrandt's original into consideration, director of conservation and restoration research of the Whitney Museum of American Art, Carol Mancusi-Ungaro, remarks that the authentication of the replica – in this case the 3D facsimile of *Het Joodse bruidje* - in relation to the original is rather contradictory: the replica by its nature is considered as something that can never be 'original', but it has to have an aura to become acceptable.[216] Nevertheless, Mancusi-Ungaro elaborates that the authentication and acceptance of the replication in relation to the original happens when it fulfills an authenticity or function Rembrandt's oil painted version cannot.[217] Mancusi-Ungaro proposes various situations in which the authentication of the replication is possible, of which a few of the situations she mentions are applicable to Rembrandt's painting and are somewhat in line with Ex's and Lowenthal's different values of authenticity and Riegl's *memory-values*.[218]

One situation Mancisi-Ungaro mentions in the context of Ex's and Lowenthal's functional authenticity is if the 3D replica would function as a replacement if the original cannot perform its own function any longer.[219] In the case of *Lascaux II* or the replicas in the *Nineveh* exhibition, for example, the copy fulfilled the functional authenticity of the original. In Cooper's words, the copy became 'original' in this sense because it got the functional feature the original does not have (anymore) or never had.[220] However, comparing the functionality of *Het Joodse bruidje* to that of the murals of *Nineveh* or the cave of *Lascaux II*, this is not necessarily as applicable at this very moment for the original painting is still around and fulfills its 'function' in het Rijksmuseum.

Nevertheless, considering the durability of the 3D facsimile's materiality in comparison to the oil painting, the chances of survival of the 3D print are higher. As Ex and Cooper explain, the copy's aged materiality will have the possibility to express the original's functionality when the original is gone, like for example *The Laocoön group.* In Mancusi-Ungaro's words, if the catastrophe would happen that Rembrandt's original would not be able to be on display due to decay, this would mean that the 3D print can become an authentic copy as it fulfills the function of the original.[221] This suggests that although the 3D print is in different materiality and age from the original, it will become as authentic as Rembrandt's original.

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[215] Barassi, 2007.
[216] Mancusi-Ungaro, C., "Authority and ethics", *Tate Papers*, (London: Tate, 8 (2007)), http://www.tate.org.uk/research/publications/tate-papers/08/authority-and-ethics (accessed April, 2018).
[217] Mancusi-Ungaro, 2007.
[218] Ex, 1993, pp. 66-69; Lowenthal, 1992, pp. 96-97; Mancusi-Ungaro, 2007.
[219] Mancusi-Ungaro, 2007.
[220] Cooper, 2007.
[221] Mancusi-Ungaro, 2007.

In the context of Ex's and Lowenthal's conceptual authenticity, the aging of the 3D print has more impact on both original and replica in the present.[222] In the words of Mancusi-Ungaro, the five year old 3D print has the power to give life to a concept of the artist by capturing its aura.[223] In the case of Rembrandt, Lowenthal explains that in a material research project on one of Rembrandt paintings in the National Gallery in 1988 conservator David Bomford already remarked that X-Ray and infrared could expose the information hidden in the layers underlying the façade, providing a seemingly more – what Ex refers to as a-historic – conceptually authentic look of Rembrandt's work than we see in the museum.[224] However, in the times Lowenthal and Ex wrote their assumptions, previous stadiums of the façade of Rembrandt's paintings could only be generated two-dimensionally. According to art-critic Wieteke van Zeil in de *Volkskrant* (2009), what is considered to be disturbing about the copy – in this case the 3D facsimile of *Het Joodse bruidje* of 2013 - is that the 3D print unveils what used to remain hidden for eternity. What could previously only be regenerated digitally can now be displayed in size, color and texture closer to Rembrandt's intention.[225] Moreover, van Zeil argues that thanks to its materiality, the 3D replica's color and texture will decay less fast than that of the original.[226] This means that over time, the print will provide a more a-historical and - in Lowenthal's words - a conceptually correct version of *Het Joodse bruidje* than Rembrandt's oil painted version.

The interviews – and especially the ones with the museum visitors - confirmed that over time, the 3D replica is considered to be more authentic than the original in the a-historical conceptual sense.[227] As Dik predicted, this means that the image the 3D print provides will disrupt what people today consider to be the authentic artist intention.[228] This way, Dik suggests that the 3D print will cause society to rethink what is considered to be Rembrandt's concept, because 3D printing starts the discussion of what version of *Het Joodse bruidje* is considered more valuable: is it *Het Joodse bruidje* which is older in materiality, but a conceptually ruined version in comparison with the replica, or is it be the 3D print that is different in materiality and less old, but in concept closer to what Rembrandt wanted? Dik suggests that this discussion caused by the authentic copy will affect the authenticity society grants Rembrandt's original *Het Joodse bruidje*, and will possibly rewrite art history.[229]

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[222] Ex, 1993, pp. 66-69; Lowenthal, 1992, pp. 96-97.
[223] Mancusi-Ungaro, 2007.
[224] Lowenthal, 1992, p. 92.; Bomford, D., et. al. *Art in the making: Rembrandt* (London: National Gallery, 1988).
[225] Lowenthal, 1992, p. 92-94.
[226] van Zeil, W., "Kopie kan origineel overtreffen"*, De Volkskrant*, 22 December 2012, https://www.volkskrant.nl/archief/kopie-kan-origineel-overtreffen~a3367503n/ (accessed April, 2018)
[227] Appendix 3. *Interview results,* 2018, pp. 3-6.
[228] van Loon, A.; Dik, J., et. al., 2017, pp. 2-11.
[229] Dik, 2015, https://www.nwo.nl/onderzoek-en-resultaten/cases/nieuw-licht-op-rembrandt-door-de-verflagen-heen.html, (accessed February, 2018)

In Schwartz's words, people will have to learn to live with the presence of two authentic versions of *Het Joodse bruidje*: the 3D print that provides a conceptually more authentic version and the original that is more authentic in materiality.[230] However, the existence of multiple versions of *Het Joodse bruidje* does not have to be harmful to Rembrandt's original or the value granted to him as an artist. In Schwartz' words, Rembrandt's original and the 3D facsimile should be seen as metaphorical twins that grow up in separate cultures: the print and Rembrandt's painting are 'raised' in two different contexts for Rembrandt's seventeenth-century version has the function of showing the creation of art and the *Zeitgeist* of Rembrandt's time, whereas the 3D printed version exemplifies the possibilities of 3D technology in 2013. Both fulfill different functions and can thus be valued for their own individual reasons and can become authentic on their own.[231] This has also happened in the case of the Lascaux cave, where the original and three copies exist in harmony for they all became authentic for their own reasons.

Nevertheless, Schwartz remarks that however different the context of the original and the various separate authenticities of its facsimiles may be, the original and the 3D print are still inseparably linked to each other as they both refer to the same image, artist and painting.[232] Latour and Lowe share this idea with Schwartz and emphasize that there is a constant exchange in meaning between copy and original for they depend on each other.[233] In this debate Lowenthal emphasizes that it is important to keep in mind that not only original and copies *age- and "*memory value*"* change in meaning, but so does society's perception of granting authentic value: the way in which the copy is considered authentic is based on the way authenticity is pursued.[234] The museum visitors I interviewed and the extensive market research of social communication specialists Kent Grayson and Radan Martinec confirm that authenticity is not considered inherent to one object. It is a phenomenon that is better understood as an assessment made by a particular evaluator in a particular context.[235] I agree that authenticity of both copy and replica is a social construction that is not static, but changes over time. Barassi's remarks that the latter is interesting for he argues that a shift in what society considers to be more authentic changes the meaning of the original, which can elevate the replica's relevance and its own historical value detached from the original it was based on.[236]

[230] Schwartz, 1996, p. 217.
[231] Schwartz, 1996, pp. 217-219.
[232] *Ibidem,* pp. 117-120.
[233] Latour; Lowe, 2011, 277-280.
[234] Lowenthal, 1992, pp. 94-96.
[235] Grayson, K.; Martinec, R., "Consumer perceptions of iconicity and indexicality and their influence on assessments of authentic market offerings'" *Journal of consumer research*, (Chicago: Journal of consumer research, 21 (2004)), pp. 296-312.
[236] Barassi, 2007.

It can be said that from the perspective of various 'authenticities' or *"*memory value*"s*, the five year old 3D facsimile could be considered authentic. The facsimile can - under certain circumstances - possibly become more authentic and can become original in the future, just like Rembrandt's painting. Even though replicas and in this case 3D prints are usually made of a more durable and less environmentally sensitive material than the original, to assure the copy withstands the test of time, the reality is that it is inevitable that the facsimile's materiality will decay as the years proceed. Considering the contemporary idolization of the materiality of objects suggests that the 'auratic' facsimile will need conservation treatments to maintain a 'healthy' material condition. However, arguing that the 3D print is a copy which is not considered a work of art, the question arises whether or not the 3D facsimile of Rembrandt's painting deserves to be conserved with the same care as the original. Moreover, because the 3D facsimile is the result of a technical reproduction method one might argue as well that reprinting *Het Joodse bruidje* can be a conservation strategy for the 3D facsimile.

5.2 The conservation of the 3D facsimile

In the second chapter of this thesis it was argued that the 3D replica with today's importance of material authenticity can never be a material substitute for Rembrandt's original painting, especially when the original still exists and is on display. However, reflecting on Marchesi's words that the replication cannot be a substitute for the original because the motive of creation is not equal, this situation is different in the case of the 3D facsimile: since a 3D copy is created to *be* a copy, a 3D copy of the authentic 3D copy would thus fulfill an identical purpose.[237] One can argue that the 3D print can be a conservation method for the conservation of the 3D print, especially because the technology has developed and can provide a better version of both the facsimile as a 3D print and as a copy of the original.

Nevertheless, analyzing the progressing life and handling of other replicas clarifies that this idea would be too simplistic. As an example, I again want to refer to the case of *Lascaux II.* In the idea of replicating the replica, *Lascaux II* was not the only replica of the prehistoric cave for two other replicas were made after this one: *Lascaux III* (2012) that was created to travel globally and *Lascaux IV* (2016) that was created with the same purpose - to conserve the original cave - as *Lascaux II*, but with the use of modern technology and new materials.[238] It is interesting to diagnose that *Lascaux III* and *IV* were not made to be replacements of the earlier replica *Lascaux II* because it could not fulfill its initial function

[237] Marchesi, 2017, pp. 270-272.
[238] L'equipe Lascaux, *Lascaux, Lascaux II, III…And next?*, October 24, 2016, https://www.lascaux.fr/en/blog/detail/25-lascaux-lascaux-ii-iiiand-next (accessed April, 2018).

anymore. Moreover, *Lascaux III* was made to serve as a temporary replacement of *Lascaux II* when it was inaccessible due to decay. As the specialized restoration team of *Atelier des Fac-Similé du Périgord* (AFSP) shows, it was decided to extensively restore the facsimile (Img. 9). This process took up to four years and was executed by four specialists that were guided by Monique Peytral who restored the original prehistoric Lascaux cave.[239] The reason why *Lascaux II* was restored instead of replaced with *Lascaux III* or *Lascaux IV* is revealed by articles published by scientific journalist Pedro Lima, who was present during the time of restoration: the replica of the prehistoric cave had become authentic for it was made with the extensive knowledge of Monique Peytral and it had cost a lot of effort, investigation and craftsmanship to make.[240] This idea was emphasized by the French president François Hollande, who declared in 2016 that "this [*Lascaux II*] is more than a facsimile, it is an oeuvre."[241] In this sense, I argue that the replicated cave is no longer just a mere copy of the prehistoric one, but it has become authentic as its functional authenticity has transformed to a material authenticity. This means that the facsimile's materiality has transformed to one that is unique in existence for it expresses the artistic expertise of Monique Peytral's hand. In the sense of Latour and Lowe's 'effort value' in combination with Riegl's gradually augmenting "age value", it would indeed seem fair that *Lascaux II* receives the same care as the original cave.[242]

Even though the 3D replica can be considered as an authentic copy like *Lascaux II* it does, however, not have the same features *Lascaux II* has: a specialized artist did not make it by hand attempting the technique with which the ancestors made the original, so the materiality of the 3D print therefore does not provide a connection with the hand of a past artist – in case of *Lascaux II* with Monique Peytral's hand. Would it be necessary to restore and conserve a 3D facsimile with the same care as the original for it cannot be considered to be a result of artistic talent? The fact that the 3D print is a technical reproduction suggests that the 3D print should be replaced and printed again, especially because of the importance of the accuracy of the technology.

However, very recent practice proves otherwise. In February of 2018, the Boijmans van Beuningen Museum in Rotterdam exhibited a replica that is 10% larger in size of Pieter Brueghel's *De toren van Babel* (1563) that was made with an assembly of modern reproduction methods by TU Delft in collaboration with the Tokyo University of Arts (Img.

[239] Atelier des Fac-Similé du Périgord, ***Restauration d'un fac-similé: Lascaux II***, May 2016, http://www.afsp-perigord.fr/projets/ (accessed May, 2018).
The restoration was executed by four painting and interior conservators: Valérie Mathias, Régis Drain, Francis Ringenbach, Aurélia Teixeira, Thierry Laurent and Gilles Lafleur.
[240] Lima, P.; "La grande averture de Lascaux II", *Les métamorphoses de Lascaux*, (Montelimar: Editions Synops), 2012, pp. 32-49.
[241] Original text: "C'est plus qu'un fac-similé, c'est une oeuvre" (translation by author) "Grotte de Lascaux. "Plus qu'un fac-similé, une oeuvre", *Ouest-France*, December 10, 2016, https://www.ouest-france.fr/culture/grotte-de-lascaux-plus-qu-un-fac-simile-une-oeuvre-4671026 (accessed May, 2018).
[242] Latour; Lowe, 2011, 277-280

10).[243] As a commissioned painting conservator Eva van Zuilen explained, the print was taken out of the exhibition because the replica had suffered damage that distorted the image. It was therefor decided that the reproduction had to be restored (Img. 11). Interestingly, van Zuilen explained that the reproduction was not simply reproduced, but that it was approached in the same way as an original painting: excessive photography and damage reports were made and the reproduction underwent hours of professional retouching. Speaking with van Zuilen revealed that the reason for restoration was commissioned by the artist, in this case Joris Dik.[244] In line with Cameron, it can be said that due to the current emphasis on material value, the replication has become a unique object with its own aesthetic and material qualities. The facsimile's materiality became one that has created a unique documenting bond with the original in the exhibition.[245] Because the reproduction has formed a unique bond with an individual – albeit only the artist - the object's material became of value and is thus considered worth saving.

Looking back at Marchesi's words that reproduction as substitution can only occur under the supervision of the artist, in this case and in the case of *Het Joodse bruidje*, for now it will be Dik who decides whether or not the replica needs to be retouched. So in line with Marchesi I argue that in the future, if Dik as the artist would not be around, reprinting the auratic copy with improved 3D printing techniques cannot substitute the 2013 version of the 3D print for reproduction will be based on the idea of others and will have different intentions that would change the concept of the authentic version.[246] I therefore conclude that if the contemporary emphasis on materiality of the original 3D print that holds the connection with the 'genuine' and the past will continue to prevail, the 3D print of *Het Joodse bruidje* cannot be substituted with a reproduction similar in materiality, color and composition.

[243] Boijmans van Beuningen exhibited this replica together with other reproductions of the original painting in the *BABEL – Oude meesters terug uit Japan* exhibition (February 3, 2018 – May 21, 2018).
[244] Appendix 5. *Interview - restoration of De toren van Babel replica*
[245] Cameron, 2007, pp. 64-65.
[246] Marchesi, 2017, p. 270.

Conclusion

This research started out of a curiosity that was raised by a face-to-face encounter with an almost indistinguishable 3D replica of Rembrandt's original painting *Het Joodse bruidje.* In order to answer the main question, whether or not 3D replication can be a conservation strategy or to what extent, and to explain the significance of the introduction of 3D printing for contemporary society's perception of art, I examined what has been written about replicas in contemporary conservation. By speaking with professionals working in the Dutch museums and museum visitors I analyzed the discussions that currently exist on 3D replication and its effects on original works of art and because of my fieldwork I have made an addition to the awareness of the consequences of the rise of these facsimiles. In this thesis the 3D print of *Het Joodse bruidje* functioned as a case study to bring together the various disciplines this research draws from in order to come to a conclusion.

By speaking to Willemijn Elkhuizen (PhD researcher at TU Delft) it became clear that 3D printing fine art is a fairly new technique that uses digitally generated information to come a three-dimensionally printed object by concentrating polycarbonate droplets. The newness of the technique revealed that it has not been possible to print every painting yet for there are still difficulties the technique has to overcome to be more accurate.

Reflecting on Hummelen and Sillé's case studies demonstrated that defining conservation was rather difficult because its actions could be considered closely related with preservation and restoration. Salvador Muñoz Viñas' theory and practicing conservator Monica Marchesi's dissertation provided the framework that clarified that the difficulty of defining contemporary conservation is due to the wide variety of people, partakers and artists involved. Moreover, it showed that contemporary conservation needs to overcome a conflict in the value granted to both concept and materiality. Introducing 3D replication into this definition and reflecting the outcomes of my interviews on this discussion, I conclude that the 3D replica as a conservation method is considered useful as a means of documentation and information regarding the conservation of Rembrandt's original. It turned out that the 3D replica could not function as a substitute of the original because not only in materiality, but it was also in the way of creation different from the original.

Comparing contemporary literature as well as the interviews with Benjamin's essay, it became clear that his idea of the original's loss of aura caused by technical reproduction is still present in contemporary society. However, Lenain's perspective proves that the augmenting use of the copy in the twenty-first century has increased the longing for aura. This has fueled the romanticization of the material qualities of Rembrandt's original as a proof of the connection with history. The interviews revealed the holistic cycle that? society is

currently situated in: the longing for the original's materiality promotes the manufacturing of the 3D copy, whereas the occurrence of the indistinguishable 3D copy enforces the importance of material authenticity.

After an explanation of Lowental's and Ex's various contemporary authenticities (functional, conceptual, material, historical and a-historical authenticity) and analyzing the articles in the *Tate Papers*, it became clear that 3D facsimile's visual and textural likeness contests these authenticities given to the original and therefore results in rejection. The 3D facsimile could elucidate what was left undiscovered until today better than any other technical reproduction method – such as *Het Joodse bruidje's* original colors - and could execute functions and authenticities the original could not – like the possibility of touch -. The interviews revealed that the main reason the 3D print was rejected was because of its effortless creation with such likeness that it could outrule the importance of the artist. Considered most threatening was the 3D facsimile's likeness that could easily assume the authenticity of the original. *Het Joodse bruidje* and its facsimile seemed indistinguishable and therefore inseparable: changes to the copy would change the original and vice versa.

Keeping in consideration that the replica would have a life after its creation, it was concluded that not only Rembrandt's *Het Joodse bruidje* aged, but also the 3D facsimile. Exploring the 3D replica from Lowenthal's and Ex's authenticities, it became clear that the five year old replica itself could become authentic both on its own and in relation to the original. The 3D print's materiality could in itself become a carrier of various authenticities, due to the appreciation of "age value" and the unique position it would occupy in 3D printing history. However, since the copy would always be related to the original, further exploration was needed for the authentication of the 3D facsimile. Using Schwartz's perspective revealed that the 3D facsimile could become more authentic because its chances of material survival were higher than the original's, and could thus provide - in theory – a more authentic experience.

Returning to contemporary conservation theory, the question whether the 3D print could be a conservation strategy was reflected on the 3D facsimile. The examples of the replicas of *Lascaux* and *De toren van Babel* demonstrated that the 'auratic' 3D print could not be substituted by an identical 3D facsimile because its material would become the carrier of a unique bond with a set moment in time. The 3D print would thus deserve the same care as Rembrandt's original.

Today, the 3D print allows *Het Joodse bruidje* to conserve what Rembrandt's original looks like now and would have looked like in its origin. It also allows Rembrandt's painting to have multiple authenticities that are valuable in various intensities to different people, which is in line with what contemporary society asks. However, this change from the focus on one single

(material) authenticity Western society today grants Rembrandt's painting caused by the - in texture, size and color - identical 3D print, disturbs what we are used to and influences the way both original and copy are perceived. However, I want to emphasize that the additional authenticities the 3D replica introduces do not at all destroy the value of Rembrandt's oeuvre and original as Benjamin suggested. On the contrary: it increases the appreciation for the Dutch painter. The 'auratic' copy and magnification of plural authenticities of the original creates awareness of the importance of cultural heritage on various levels, which will help in the conservation of the original.

Furthermore, it should be kept in mind that 3D printing fine art is still in an early stage. However, it is unstoppable that this technique will develop together with the 3D scanning devices that are needed for the production of the print. What is interesting for further exploration is what will happen when prints are generated that express the results of Joris Dik's material research. What needs to be explored is whether newly generated Rembrandts can be considered works of art. The importance of material authenticity can shift to a more conceptual or functional authenticity. It will be interesting to see if it the 3D print of *Het Joodse bruidje* will be able to exceed the original as predicted. This will challenge the idea of what will happen to the purpose and function of the original artist, for his or her importance, is replaced by the 3D printer as the artist. Returning to Benjamin's idea that 3D printing means the death of art, I would say otherwise. The work of deceased artists can be brought back to life and can create more oeuvres to endorse and feed the popularity of the artist. However, it is worth considering what it would mean that instead of the human genius, the 3D print becomes the artist.

The main question of this thesis was approached from different related fields, but was written in a Western setting and with a focus on Dutch museums and their visitors. Also, it was written from an art historical and esthetical perspective. Further research is needed in various fields apart from these perspectives because more fields will be affected by 3D facsimiles of fine art and can benefit from further exploration. One of these would be a stronger focus on museum studies and art education to explore the usefulness of 3D replication for exhibition purposes, the education of the visitor and the marketing of the museum. Secondly, it is worth exploring the effects of the authentic 3D print on the art market. And thirdly, it would be interesting to do profound research on how different cultures and other European countries or the United Stated react to these prints and deal with the 3D facsimile. Fourthly, further research is needed into the legal aspects and copyright when it comes to the creation of 'new' Rembrandts. Lastly, the conservation of the 3D facsimile was only briefly mentioned. It would therefore be interesting to explore how the 'auratic' facsimile should be restored because it is uncertain how color and material will change over time.

This research has taught me that the material aspects of the work of art are still considered to provide the most important connection together with the artist. Technical reproduction methods disturb this thought, especially when an indistinguishable copy in both visual and textural aspects - which in the future might be better in quality - is around.

Nevertheless, this research has shown that Rembrandt is more than just the material aspects of his paintings: his concept and historical relevance are just as important. Even though the contemporary material approach rejects the 3D print, Rembrandt's materiality will need the copy to be conserved and to keep it from extinction. Even though the 3D print will never be a substitute for *Het Joodse bruidje*, it can and will help conserve originals in a possible future with a different perception of art that asks for multiple authenticities.

Figures and images

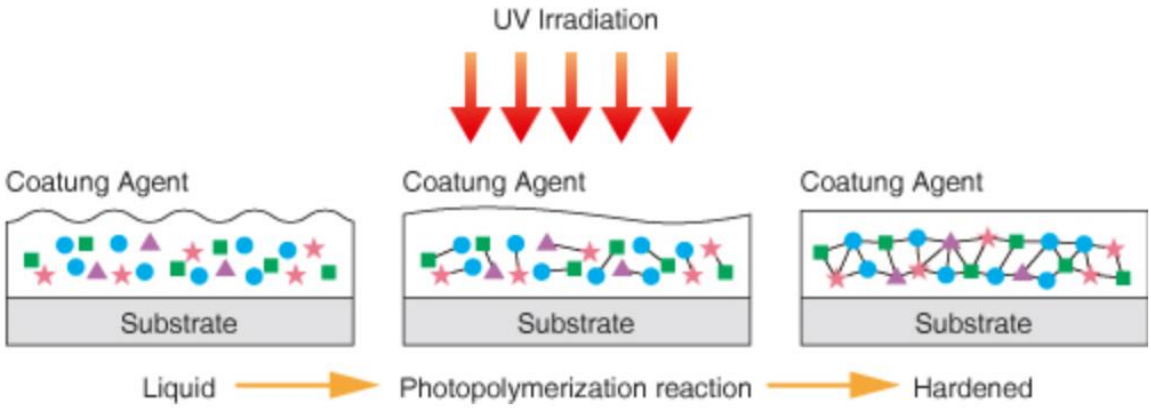

Figure 1. *SLA connections*

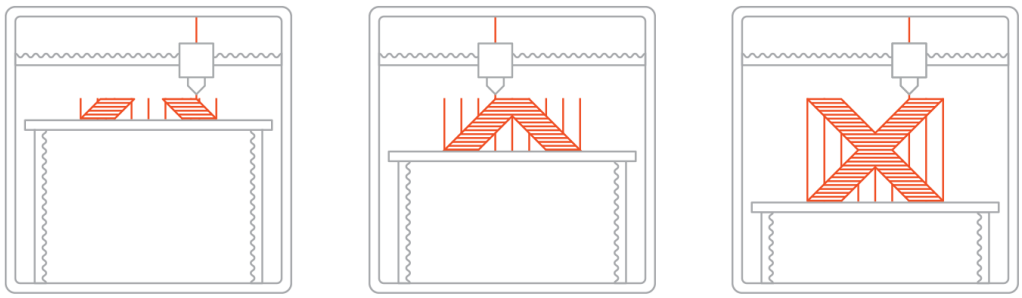

Figure 2. *Additive printing*

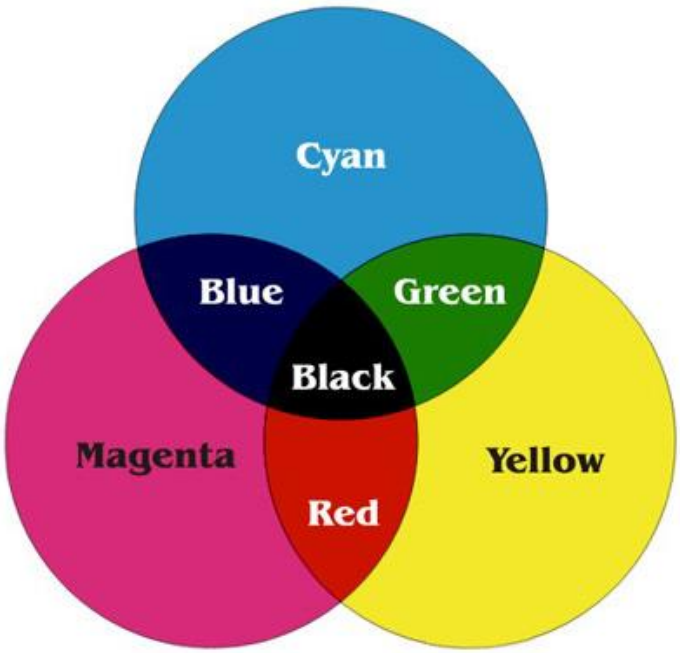

Figure 3. *CMYK subtractive color model*

Figure 4. *Camera set up and printing method*

Image 1. *Het Joodse bruidje*, Rembrandt van Rijn, 1665-1669, oil on canvas, 122 x 166 cm, Rijksmuseum, Amsterdam, SK-C-216.

Image 2. *Close up of the 3D printed sleeve of Isaac*, Tim Zaman, 2015

Image 3. *Close up of the 3D printed bride's face*, Tim Zaman, 2015

Image 4. *Close up of the 3D printed sleeve of Rebecca*, Tim Zaman, 2015

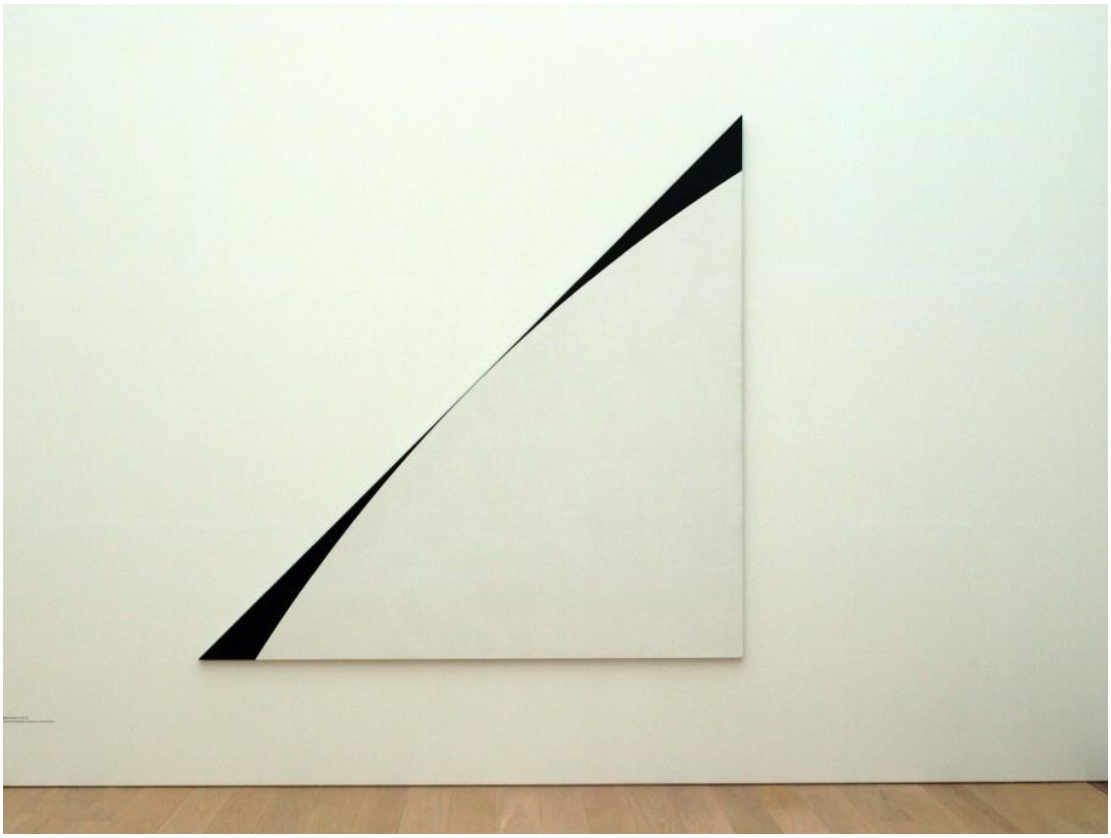

Image 5. *White Triangle with black curve*, Ellsworth Kelly, 1972, oil on canvas, 267 x 246 cm, Stedelijk Museum, Amsterdam, A 35014.

Image 6. *Campi arati e canali d'irrigazione*, Pino Pascali, 1968, colored water and steel, 382 x 382 x 5 cm, Kröller Müller Museum, Otterloo,

Image 7. Visitor touching a 3D print of *El caballero de la mano en el pecho,* El Greco, 1580, 81,8 x 66,1 cm, Museo del Prado, Madrid, P000809. (3D SLA print with polylactic acid (PLA))

Image 8. 3D print of *Het meisje met de parel*, Johannes Vermeer, 1665, oil on canvas, 44 x 39 cm, het Mauritshuis, Den Haag, 670. (SLA printed by Océ Technologies B.V Venlo)

Image 9. *The restoration of Lascaux II*, Gilles Lafleur, 2012, Montignac.

Image 10. *110 % replica of De toren van Babel*, TU Delft & Tokyo University of Arts, 2016-2017, oil and digital print on panel, 125,4 x 170,5 cm, Boijmans van Beuningen, Rotterdam.

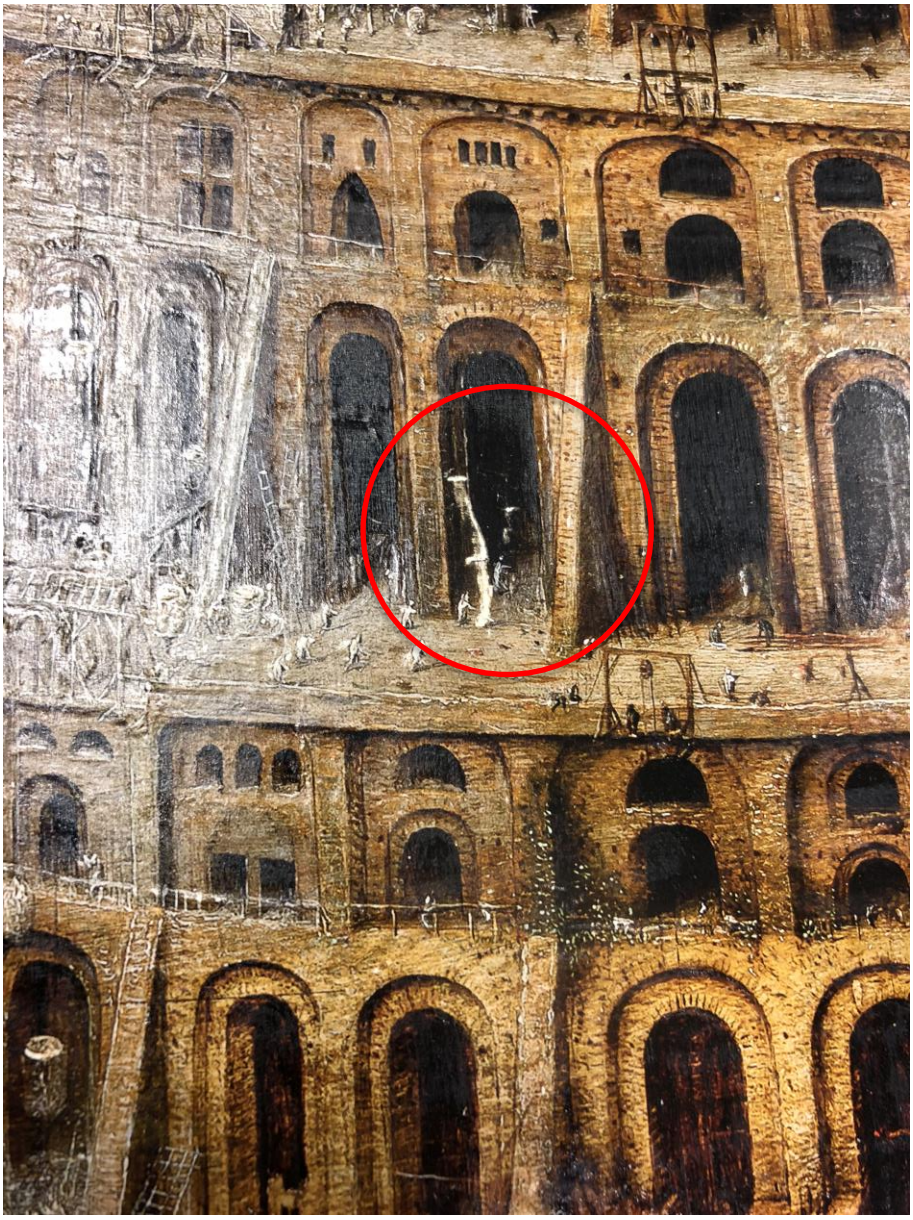

Image 11. *Damage on the 110 % replica of De toren van Babel*, TU Delft & Tokyo University of Arts, oil and digital print on panel, 2016-2017, 125,4 x 170,5 cm, Boijmans van Beuningen, Rotterdam.

Figure and image sources

Figure 1. *SLA connections*, https://www.ushio.com/ (accessed March, 2018)

Figure 2. *Additive printing,* https://www.3dhubs.com/ (accessed March, 2018)

Figure 3. *CMYK subtractive color model,* https://www.designblog.rietveldacademie.nl/ (accessed March, 2018)

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Image 1. *Het Joodse bruidje,* https://www.rijksmuseum.nl/ (accessed February, 2018)

Image 2. *Close up of the 3D printed sleeve of Isaac*, Tim Zaman, 2015

Image 3. *Close up of the 3D printed bride's face*, Tim Zaman, 2015

Image 4. *Close up of the 3D printed sleeve of Rebecca*, Tim Zaman, 2015

Image 5. *White Triangle with black curve,* https://www.stedelijk.nl/ (accessed April, 2018)

Image 6. *Campi arati e canali d'irrigazione,* https://krollermuller.nl/ (accessed May, 2018)

Image 7. Visitor touching a 3D print of *El caballero de la mano en el pecho:* https://museodelprado.es/ (accessed April, 2018)

Image 8. 3D print of *Het meisje met de parel,* picture by author (March, 2018)

Image 9. *The restoration of Lascaux II,* picture by Philippe Psaïla, http://www.psaila.net/report/lascaux/index.php (accessed May, 2018)

Image 10. *110 % replica of De toren van Babel*, picture by author (February, 2018)

Image 11. *Damage on the 110 % replica of De toren van Babel,* picture by author (February, 2018)

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Appendix 1. Questionnaire – Application of 3D printed replicas

Questionnaire: Applicatie van 3D-geprinte replica's

Naam:
Instantie:
Datum:

Beste deelnemer,

Voor mijn afstudeeronderzoek naar de toepasbaarheid van 3D-geprinte replica's worden enkele personen en instanties die gerelateerd zijn aan de tentoonstelling van kunst/de conservering en restauratie van kunst/of werkzaam in de kunsthandel uitgenodigd om deze questionnaire in te vullen. De questionnaire is voortgekomen vanuit samenwerking met het team van Prof. dr. J. Dik, Technische Universiteit Delft dat zich bezighoudt met het vervaardigen, onderzoeken en optimaliseren van het repliceren van kunstwerken door het gebruik van 3D-print-technieken. Het onderzoek zal worden verwerkt in een thesis die door mij, Liselore Tissen, masterstudente Arts & Culture aan Universiteit Leiden, onder leiding van Prof. dr. C.J.M. Zijlmans, Universiteit Leiden en Joris Dik, zal worden geschreven.

Alvast bedankt voor uw deelname,

Liselore Nancy Mathilde Tissen BA
MA Arts & Culture: Art of the Contemporary World & World Art
Studies Kitty Zijlmans, Universiteit Leiden
Joris Dik, Technische Universiteit Delft

Questionnaire: Applicatie van 3D-geprinte replica's

Bent u bekend met 3D-printen en de mogelijkheden hiervan?

Welke mogelijkheden ziet u in-3D printen?

Wat is uw houding tegenover het vervaardigen van replica's?

Zou u er iets voor voelen om een replica van een kunstwerk te laten maken door middel van-3D print?

Zo ja, aan welke criteria zou dit kunstwerk moeten voldoen eer u hier een replica van zou laten maken?
Zo nee, wat zijn uw bezwaren?

Zou u open staan voor het toepassen van 3D-print ter behoud van kunstwerken (restauratie)? ja

Zo ja, hoe denkt u dat 3D-print het behoud van kunstwerken kan bevorderen/de levensduur van een kunstwerk kan verlengen? Zo nee, wat zijn uw bezwaren?

Denkt u dat replica's van kunstwerken door 3D-printen een collectie/tentoonstelling kunnen verrijken (wanneer deze bijvoorbeeld ontbreken doordat deze uitgeleend zijn)?

Zo ja, hoe zou u de 3D-replica's inzetten?
Zo nee, wat is uw bezwaar tegen het gebruik van 3D-replica's?

Welke indruk heeft u van het sample? Voldoet het aan uw verwachtingen/is het sample overtuigend voor u als kijker?

Wat is uw mening over de kleur van het sample?

Wat is uw mening over de textuur van het sample?

Wat is uw mening over de optische gelijkenis met het echte originele kunstwerk?

Wat zijn volgens u sterke/zwakke punten van het sample?

Waaraan zou volgens u het sample moeten voldoen om een overtuigende indruk te maken op de beschouwer?

Heeft deze questionnaire uw interesse in de toepassing van 3D-replica's binnen collecties/tentoonstellingen vergroot of verkleind? Graag uw toelichting.

Heeft deze questionnaire uw interesse in de toepassing van 3D-printen en de mogelijkheden ervan binnen het behoud van beeldende kunstwerken vergroot?

Appendix 2. Interview results

Applicatie van 3D-geprinte replica's

De toepasbaarheid en receptie van de introductie van 3D-replica's binnen de presentatie en conservering van kunst.

Liselore Nancy Mathilde Tissen
Prof. dr. C.J.M. Zijlmans, Universiteit Leiden
Prof. dr. J. Dik, Technische Universiteit Delft
MA Arts & Culture*: Art of the Contemporary World & World Art Studies*
Questionnaire: Applicatie van 3D
geprinte replica's Februari 2018

Inhoud

Inleiding

3D-printen is een techniek die tegenwoordig steeds meer gebruikt wordt en onder de aandacht komt. In 1986 deed Charles Hull (1953) de eerste poging tot het printen van 3D-objecten door een opeenstapeling van lagen UV-uitgehard polymeer, en met succes. De techniek heeft zich door de jaren heen sterk ontwikkeld en is dusdanig geavanceerd dat we in staat zijn om industriële metalen voorwerpen, voedsel en zelfs organen te printen. Deze techniek heeft inmiddels ook zijn intrede gedaan in de kunstwereld; 3D-geprinte onderdelen kunnen worden gebruikt om missende onderdelen van beelden te vervangen. Dit is bijvoorbeeld gebeurd tijdens de restauratie van *de Denker* van Auguste Rodin (2009-2011). Daarnaast kan de techniek worden gebruikt ter reconstructie en om bijvoorbeeld reliëfs die verloren zijn gegaan weer zichtbaar te maken, zoals dat in de *Nineveh* tentoonstelling in het Rijksmuseum van Oudheden is gedaan (20 oktober 2017-25 maart 2018).

De Faculteit Werktuigbouwkunde, Maritieme Techniek & Technische Materiaalwetenschappen (3ME) van de Technische Universiteit Delft (TU Delft) houdt zich bezig met 3D-printtechnieken en de toepassingen die dankzij deze techniek mogelijk zijn binnen de kunstwereld. Het team van prof. dr. J. Dik houdt zich bezig met de toepasbaarheid van 3D-technologie voor de conservering en restauratie van kunstwerken en wil breder exploreren hoe deze techniek in de kunstwereld gebruikt kan worden. Dit heeft ertoe geleid dat er in samenwerking met Canon, Océ en Willemijn Elkhuizen (PhD kandidate aan TU Delft) een 3D-scan- en printmethode wordt ontwikkeld die zowel de kleur, lichtweerkaatsing als textuur van een schilderkunstwerk kan nabootsen. Dit heeft geleid tot het vervaardigen van 3D-replica's van verscheidene schilderijen. TU Delft heeft enkele schilderijen van Vincent van Gogh en Rembrandt van Rijn gescand en door middel van 3D-printen gereproduceerd, met een verbluffend resultaat.

Het is onvermijdelijk dat deze technologie in de toekomst gebruikt zal worden en daarom is het naar mijn mening van belang dat er onderzoek wordt gedaan naar de toepasbaarheid van deze techniek voor het behoud van kunstwerken. Daarnaast is het belangrijk de reactie op 3D-replica's door musea, professionals en museumbezoekers te onderzoeken. De introductie van 3D-techniek in de kunstwereld leidt tot veel vragen en roept op tot discussie: wat gebeurt er als wij in grote oplage een kunstwerk kunnen printen dat niet alleen qua kleur, maar ook textuur overeen komt met het origineel? Hoe verhoudt een 3D-facsimile zich tot het echte kunstwerk? Is een 3D-facsimile een kunstwerk op zich?

1. Opzet onderzoek

Het onderzoek bestond uit een questionnaire van negen vragen, waarvan acht open vragen die betrekking hebben op de receptie van 3D-replica's en de inzetbaarheid hiervan voor tentoonstellings- en restauratieve doeleinden. De resterende vraag (met sub-vragen) heeft betrekking op een print van *de Zonnebloemen* van Vincent van Gogh, die ter demonstratie is getoond aan de geïnterviewden. De vragen zijn opgesteld in overleg met prof.dr. J. Dik van de Technische Universiteit Delft en met prof.dr. C.J.M. Zijlmans van de Universiteit Leiden. De vragen zijn afgestemd op het onderwerp van een te schrijven masterscriptie aan de Universiteit Leiden door de auteur dezes over de receptie van 3D-replicaties en hoe deze techniek inzetbaar kan zijn ter conservering van kunstwerken.

De questionnaire is afgenomen in de periode november 2017 tot en met januari 2018 bij vijftien personen van diverse instanties met verschillende functies (als 'professionals'). Hier tegenover heb ik vijftien personen gezet die niet werkzaam zijn in de kunstwereld, nooit tot regelmatig musea bezoeken, en gerekend kunnen worden tot 'niet-professionals'.

2. Resultaten

Aan de hand van de interviews en vergaarde kennis kan er worden gesteld dat iedereen, zowel professionals als niet-professionals, op de hoogte zijn van het bestaan van 3D-printtechniek en waar deze voor gebruikt kan worden. Opvallend is dat niet-professionals 3D-print vooral associëren met de medische wereld door het printen van organen en het gebruik in de industrie zoals het printen van machineonderdelen. Deze groep is niet of nauwelijks op de hoogte van de mogelijkheid van het printen van kunstwerken of archeologische objecten.

De manier waarop professionals de techniek zouden gebruiken is zeer gevarieerd. Opties voor het gebruik van deze techniek zijn voornamelijk in de educatieve rol die de replica's kunnen vervullen. De prints kunnen dienen ter verduidelijking van een kunstwerk door het werk bijvoorbeeld uitvergroot te gebruiken of tast toe te staan. Ook ziet men de optie om archeologische voorwerpen en verloren objecten te reconstrueren door middel van deze techniek. Ten slotte wordt met name vanuit professionals die werken met moderne kunst aangehaald hoe deze techniek kan dienen als een nieuw middel dat door kunstenaars gebruikt kan en zal worden.

De grote meerderheid van beide partijen staat positief tegenoven het bestaan van replica's en repliceren zelf. Hier moet aan toegevoegd worden dat beide partijen van mening zijn dat er duidelijk gecommuniceerd moet worden naar de bezoeker wanneer een replica op zaal wordt gehangen. Ook wordt er benadrukt dat de replica niet als een vervanging van een kunstwerk moet gelden of een kunstwerk op zichzelf is, maar dat deze een doel moet dienen ten gunste van het originele kunstwerk. Een dergelijk doel kan een educatief doel zijn, bijvoorbeeld door de mogelijkheid te bieden om een object dat zich normaliter in een vitrine bevindt aan te raken.

Wat betreft het vervaardigen van een replica van een kunstwerk zijn de meningen meer verdeeld. Van de professionals zou meer dan de helft (57.1%) het overwegen om een replica te maken. Daarbij is het motief om deze in te zetten voor educatieve doeleinden, het verhaal rondom het originele kunstwerk te versterken of om replica's in te zetten waar kunstwerken van hun originele locatie of functie zijn verwijderd. De groep professionals die niet geheel voor het uitvoeren van replica's is (35.7 %), voegt toe dat deze het bestaan van de 3D-replica niet bezwaarlijk vindt, maar dat de replica's niet in de museale ruimte horen en dat ze niet tussen originele kunstwerken geplaatst dienen te worden, tenzij het plaatsen een doel dient en goed gecommuniceerd is naar de buitenwereld. De enkelen (7,2%) die tegen het repliceren van kunstwerken zijn door middel van 3D-print, beargumenteren dat het originele kunstwerk op deze manier qua materialiteit en authenticiteit waarde verliest, aangezien het origineel door deze techniek wordt gedegradeerd tot slechts een tweedimensionaal 'plaatje' dat in grote oplagen beschikbaar is en geproduceerd kan worden. Deze laatste mening wordt ook gedeeld door een groot deel van de niet-professionals, maar zij zien dit juist als een positieve eigenschap: hierdoor kan het kunstwerk nog overtuigender worden gereproduceerd dan dat een poster dat kan en dit kan ten goede komen aan de marketing van een werk of museum. Wel wordt er meerdere keren aan toegevoegd dat het van belang is dat de visuele gelijkenis met het origineel een zwaarwegende factor is.

De mening over de inzet van deze techniek voor het behoud van kunst en het idee om in te zetten als restauratiemethode, is bij beide partijen positief. Er wordt vooral benadrukt dat 3D-print, wanneer de technologie ver genoeg is, een uiterst nauwkeurig middel zou zijn voor het repliceren en vervangen van missende onderdelen van kunstwerken en voor het vullen van lacunes. Ook wordt de techniek nuttig gevonden als middel om de huidige staat van kunstwerken vast te kunnen stellen, waarbij de print als het ware als een conditierapport fungeert. Hierdoor zullen degradatie en kleurveranderingen in de toekomst bijgehouden kunnen worden. Daarnaast wordt er opgemerkt -door restaurators en conserveringsmedewerkers- dat een 3D-replica uiterst nuttig kan zijn als stand-in voor een origineel of als materiaal om mogelijke restauratieve ingrepen op te testen alvorens er wordt overgegaan op restauratie van het origineel. Er moet wel aan worden toegevoegd dat zowel professionals als niet-professionals benadrukken dat het van belang is dat er wordt gekeken hoe 3D-applicaties en het polymeer waarvan zij gemaakt zijn, degraderen en hoe deze applicaties op een reversibele manier kunnen worden aangebracht op het kunstwerk, als dit zou gebeuren.

Over de inzet van 3D-techniek voor het aanvullen van collecties en het verrijken van tentoonstellingen is men minder enthousiast. Bijna twee-derde (64,3%) van de professionals is tegen de inzet van replica's ter aanvulling van een collectie. Het meest aangedragen argument hiervoor is dat er van musea verwacht wordt dat zij originele kunstwerken tonen. Het tentoonstellen van replica's zou voor de gemiddelde museumbezoeker geloofwaardig zijn en, wanneer de print niet goed uitgevoerd is, zou deze een verkeerde boodschap kunnen overbrengen. De overige 36,7% is het hiermee eens, maar ziet het nut van 3D-replica's ter aanvulling van een tentoonstelling wel in wanneer deze een educatief doel dienen en het verhaal rond het oeuvre van een kunstenaar kunnen versterken. Dit kan bereikt worden door bijvoorbeeld onderdelen te vergroten, of om de optie tot aanraken aan te bieden voor kunstwerken die veel impasto hebben –en dus uitnodigen tot aanraking-. De niet-professional reageert enthousiaster op het gebruik van replica's in een tentoonstelling; 80,0% zou wel replica's willen zien in een tentoonstelling. De replica's zouden kunnen dienen om het oeuvre van de kunstenaar te verhelderen. Ook kunnen ze dienen om kunstwerken tentoon te stellen die normaliter niet toegankelijk zijn voor het Nederlandse publiek, omdat zij elders worden tentoongesteld. Wel wordt hieraan toegevoegd dat er duidelijk gecommuniceerd moet worden dat het tentoongestelde om een replica gaat en waar het origineel dan wel te bezichtigen is.

Wat betreft het sample dat gebruikt is voor het onderzoek, een print van een reproductie van *de Zonnebloemen* van Gogh, werd er door de niet-professionals enthousiaster gereageerd dan door de professionals. De niet-professionals waren allen (100.0%) zeer onder de indruk van met name de textuur van het werk. De niet-professionals vonden dat voornamelijk de kleuren en transparantie missen in het werk. Het sterkste punt van het sample bleek unaniem de textuur van het werk te zijn. Bij de professionals werd er gevarieerd gereageerd; de helft reageerde positief, een zesde was neutraal en een derde was negatief. De replica had volgens de neutrale en negatieve stemmen een monotone indruk en de hard en scherpe lijnen die normaliter in het reliëf aanwezig zijn, ontbraken. Hierdoor komt het impasto ongeloofwaardig over. Wat betreft de kleuren werd er door de professionals overwegend negatief gereageerd (66,7%), aangezien het werk volgens de professionals transparantie miste en de warme kleur die door de kunstenaar wordt aangebracht –en

tevens voor de aura van het werk zorgt- was ook afwezig. Hierdoor gaf het werk een kille en grauwe indruk. De textuur van het sample werd net als de algehele indruk uiteenlopend beoordeeld. Iets minder dan de helft (43,3%) is positief over de textuur van het werk en vond het uitnodigen tot aanraking. De anderen zijn negatief over de textuur, aangezien de impasto niet goed uitkomt en het werk hierdoor heel erg 'plastic' overkomt. De materialiteit van de 3D-print werd hiermee in verband gebracht en er wordt geadviseerd om in de toekomst te proberen op een elastischere ondergrond te printen, in plaats van op een solide polymeren plaat.

Ten slotte kan er geconstateerd worden dat de questionnaire vooral bij de niet-professionals als waardevol en kennisvergrotend wordt geacht; elke participant (100.0%) zegt dat de interesse in het gebruik van 3D-replicatie voor het tentoonstellen van kunst is vergroot, voor de interesse in toepassing voor de conservering en restauratie van kunst is dit de grote meerderheid (93.3%). Bij de professionals is de interesse in de toepassing van 3D-replicatie voor zowel tentoonstellings- en restauratiedoeleinden gelijk gebleven (78,6% en 71,4%). Dit kan samenhangen met het feit dat de professionals meer op de hoogte waren van de toepassing van deze technologie binnen de tentoonstelling en restauratie van kunst dan de niet-professionals.

Nawoord

Het afnemen van de questionnaire heeft tot veel interessante en boeiende gesprekken geleid. Ik heb hierdoor geleerd dat men bekend is met de techniek en de werkzaamheden van het team van prof. Dik, maar dat de receptie van deze techniek zeer verschillend is tussen de professionals. Opmerkelijk is dat 3D-replicaties niet worden beschouwd als kunstvorm en dat deze met name interessant gevonden wordt als middel om meer over het origineel te vertellen op educatieve wijze of fungerend als conditierapport. De tendens die er bij de museumbezoeker is, is anders dan die bij de professionals, wat tot interessante tegenstellingen leidt als deze meningen met elkaar worden vergeleken. Door de gesprekken werd ik vaak verrast en geïnspireerd, wat mij aan het denken zette en waardoor ik een goed beeld heb gekregen van de opinies die er nu spelen. Ook ontdekte ik waar discussiepunten ontstaan. Deze bevindingen en gedachten zullen invloed hebben op de manier waarop ik mijn scriptie zal vormgeven. Ook hebben de afspraken en bijeenkomsten ervoor gezorgd dat er meer aandacht is ontstaan rondom dit onderwerp en heb naast vele kritische ook vele positieve reacties mogen ontvangen.

Ik wil graag Alexandra van Dongen (Conservator pre-industriële vormgeving, Boijmans van Beuningen en het Wereldmuseum, Rotterdam), Annemiek Spronk en Wouter van der Horst (Afdeling Educatie, Rijksmuseum, Amsterdam), Benno Tempel (Directeur, Gemeentemuseum, Den Haag), Lydia Beerkens (Senior restaurator van Moderne en Hedendaagse kunst, Stichting Restauratieatelier Limburg, Maastricht), Maaike Roozenburg (Zelfstandig ontwerper, Maaike Roozenburg Studio, Amsterdam), Marlies Kleiterp (Hoofd tentoonstellingen, De Hermitage, Amsterdam), Marrigje Rikken (Hoofd collecties, Frans Hals Museum, Haarlem), Frits Scholten (Senior conservator beeldhouwkunst, Rijksmuseum, Amsterdam), Charlotte van Lingen (Senior conservator, Kunsthal, Rotterdam), Alice van der Knokke (Behoud en Beheer, van Abbemuseum, Eindhoven), Kees van den Meiracker (Hoofd collectie en conservering, van Gogh Museum, Amsterdam), Lucas Petit (Conservator collectie oude Nabije Oosten, Rijksmuseum van Oudheden, Leiden), Edwin Buijsen (Hoofd collecties, Mauritshuis, Den Haag), Stijn Huijts (Artistiek directeur, Bonnefantenmuseum, Maastricht) bedanken voor de interesse in mijn onderzoek en de waardevolle en inspirerende conversaties over dit onderwerp.

Bronnen

Barassi, S.; Barger, M.; Beerkens, L.; “Inherent Vice: The Replica and its Implications in Modern Sculpture Workshop” , *Tate Papers*, London: Tate Publishing, 8 (2007)

Elkhuizen, W., *Topographical scanning and reproduction of near-planar surfaces of paintings,* San Francisco: SPIE, 2014

Elkhuizen, W., *Reproducing oil paint gloss in print for the purpose of creating, reproductions of Old Masters*, San Francisco: SPIE, 2014

Participerende instellingen:

- Boijmans van Beuningen, Rotterdam
- Bonnefantemuseum, Maastricht
- Frans Hals Museum, Haarlem
- Gemeentemuseum, Den Haag
- Hermitage, Amsterdam
- Kunsthal, Rotterdam
- Maaike Roozeburg Studio, Amsterdam
- Mauritshuis, Den Haag
- Rijksmuseum van Oudheden, Leiden
- Rijksmuseum, Amsterdam
- Stichting Restauratieatelier Limburg (SRAL), Maastricht
- van Abbemuseum, Eindhoven
- Van Gogh Museum, Amsterdam
- Wereldmuseum, Rotterdam

Appendix 3. Advise for the Technical University of Delft

Adviesrapport: Applicatie van 3D-geprinte replica's

De toepasbaarheid en receptie van de introductie van 3D-replica's binnen de presentatie en conservering van kunst.

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Onderzoeksstage: Applicatie van 3D-geprinte replica's Februari 2018

Inhoud

Inleiding

3D-printen is een techniek die tegenwoordig steeds meer gebruikt wordt en onder de aandacht komt. In 1986 deed Charles Hull (1953) de eerste poging tot het printen van 3D-objecten door een opeenstapeling van lagen UV-uitgehard polymeer, en met succes. De techniek heeft zich door de jaren heen sterk ontwikkeld en is dusdanig geavanceerd dat we in staat zijn om industriële metalen voorwerpen, voedsel en zelfs organen te printen. Deze techniek heeft inmiddels ook zijn intrede gedaan in de kunstwereld; 3D-geprinte onderdelen kunnen worden gebruikt om missende onderdelen van beelden te vervangen. Dit is bijvoorbeeld gebeurd tijdens de restauratie van *de Denker* van Auguste Rodin (2009-2011). Daarnaast kan de techniek worden gebruikt ter reconstructie en om bijvoorbeeld reliëfs die verloren zijn gegaan weer zichtbaar te maken, zoals dat in de *Nineveh* tentoonstelling in het Rijksmuseum van Oudheden is gedaan (20 oktober 2017-25 maart 2018).

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Het is onvermijdelijk dat deze technologie in de toekomst gebruikt zal worden en daarom is het naar mijn mening van belang dat er onderzoek wordt gedaan naar de toepasbaarheid van deze techniek voor het behoud van kunstwerken. Daarnaast is het belangrijk de reactie op 3D-replica's door musea, professionals en museumbezoekers te onderzoeken. De introductie van 3D-techniek in de kunstwereld leidt tot veel vragen en roept op tot discussie: wat gebeurt er als wij in grote oplage een kunstwerk kunnen printen dat niet alleen qua kleur, maar ook textuur overeen komt met het origineel? Hoe verhoudt een 3D-facsimile zich tot het echte kunstwerk? Is een 3D-facsimile een kunstwerk op zich?

1. Opzet onderzoek

Het onderzoek bestond uit een questionnaire van negen vragen, waarvan acht open vragen die betrekking hebben op de receptie van 3D-replica's en de inzetbaarheid hiervan voor tentoonstellings- en restauratieve doeleinden. De resterende vraag (met sub-vragen) heeft betrekking op een print van *de Zonnebloemen* van Vincent van Gogh, die ter demonstratie is getoond aan de geïnterviewden. De vragen zijn opgesteld in overleg met prof.dr. J. Dik van de Technische Universiteit Delft en met prof.dr. C.J.M. Zijlmans van de Universiteit Leiden. De vragen zijn afgestemd op het onderwerp van een te schrijven masterscriptie aan de Universiteit Leiden door de auteur dezes over de receptie van 3D-replicaties en hoe deze techniek inzetbaar kan zijn ter conservering van kunstwerken.

De questionnaire is afgenomen in de periode november 2017 tot en met januari 2018 bij vijftien personen met verschillende functies bij diverse instanties in heel Nederland. De resultaten hiervan zijn verwerkt en zijn te vinden in de bijlage 'Uitkomsten interviews' onder de tab 'Questionnaire professionals'. Hier tegenover zijn vijftien personen gezet die niet werkzaam zijn in de kunstwereld, nooit tot regelmatig musea bezoeken, en die voor dit onderzoek gerekend worden tot 'niet-professionals'. De resultaten van interviews met hen zijn te vinden in dezelfde bijlage onder de tab 'Questionnaire niet-professionals'.

2. Maatregelen

Uit de interviews met professionals en niet-professionals blijkt dat er interesse is voor het mogelijke gebruik van deze techniek, maar dat er een zekere scepsis heerst over het gebruik ervan in museale context. De algemene tendens is dat er met name interesse bestaat voor de techniek voor educatieve doeleinden of ter versterking van het verhaal van een tentoonstelling.

Mijn advies is daarom om verder te onderzoeken welke mogelijkheden er zijn om niet slechts een kunstwerk één op één te kopiëren, maar mogelijkheden te bedenken waardoor het kopiëren van kunstwerken een middel kan worden ten gunste van het originele kunstwerk. Denk hierbij aan het op hoge resolutie uitvergroten van kunstwerken, het apart printen van verschillende onderdelen van een kunstwerk die normaliter niet zichtbaar zijn, het verdikken van het reliëf voor tast of het printen van kunstwerken in verschillende stadia van verval. Het voordeel is dat de replica geen exacte facsimile is en wordt beschouwd als middel. Hierdoor zullen onderwerpen als copyright en aantasting van de authenticiteit van het origineel wellicht minder op tafel komen, aangezien er door abstrahering, opblazen of verkleinen een duidelijk onderscheid ontstaat tussen origineel en replica. Daarnaast dient de replicatie of reconstructie een doel ten gunste van het kunstwerk, waardoor niet alleen de appreciatie voor het nut van de 3D-print wordt vergroot, maar ook die van het originele kunstwerk.

De techniek wordt ook voor restauratie interessant gevonden, doordat replica's kunnen fungeren als stand-ins. Hierop kunnen ingrepen kunnen worden gedaan en mogelijke restauratiemethoden kunnen worden getest alvorens het echte kunstwerk te retoucheren en het daarmee mogelijk te beschadigen.

Mijn advies is om te bekijken of er met betrekking tot restauratie van kunstwerken een toegankelijke en gebruiksvriendelijke software ontwikkeld kan worden en een goedkope manier van 2,5D-en 3D-printen. Hierdoor zou de techniek voor restaurators inzetbaar kunnen zijn om makkelijk en goedkoop samples te vervaardigen alvorens over te gaan op het origineel. Er kunnen restauratieve fouten voorkomen worden, doordat er op een eenvoudige manier getoond kan worden wat de consequenties zijn van mogelijke ingrepen, daardoor wordt de kans op het gebruik van de juiste methode met de optimale resultaten vergroot.

Ook is er vanuit de conservering en restauratie belangstelling voor het inzetten van deze replica's als conditierapporten. Hiermee kan bijvoorbeeld worden vastgelegd wat de staat van een kunstwerk was voordat het ging reizen of kan er worden afgelezen hoe een kunstwerk in de loop van tijd is veranderd. Daarnaast is er interesse voor het gebruik van de techniek om lacunes –waarvan te achterhalen is wat afgebeeld was- te vullen. Het is echter tot nu toe nog onbekend hoe de 3D-prints reageren op lange termijn.

Ik adviseer om een onderzoek te starten naar het verval en de reactie van het materiaal en kleur waarvan de prints gemaakt zijn. Op deze manier kan er worden geconstateerd of de prints op lange termijn bruikbaar zijn als conditierapporten en of zij een duurzame manier van restaureren kunnen bieden. Ook moet er onderzocht worden wanneer 2,5D-print zal worden gebruik om lacunes te vullen, hoe deze op een reversibele manier kunnen worden aangebracht op het origineel zonder het originele materiaal aan te tasten.

Wat betreft het sample dat gebruikt is voor het onderzoek valt er nog veel te winst te behalen. Met name het gebrek aan transparantie van het materiaal lijkt het grootste probleem te zijn en dient verder ontwikkeld te worden. Mijn advies is om met name aandacht te besteden aan het verbeteren van de glans en de transparantie van het werk. Wanneer er voor de transparantie en de gelaagdheid van het kunstwerk een verbeterde techniek of materiaal kan worden ontwikkeld, dan zal automatisch het monochrome uiterlijk waarvan nu sprake is, verholpen kunnen worden. Daarnaast zal een betere gelaagdheid een overtuigende indruk geven, aangezien deze beter de gebruikte techniek van de kunstenaar in het origineel benadert. Hierdoor is het ook mogelijk dat het 'plastic' en dode gevoel van de materie en het gebrek van de hand van de kunstenaar verbeterd worden. Dit zal de overtuigingskracht van de replica ten goede komen, de waardering van de bezoeker vergroten en de acceptatie binnen de museale sector vergemakkelijken, naarmate de replica het origineel beter benadert er hierdoor minder kans is op deceptie en bedrog.

Ook is het van belang dat er een ander basismateriaal wordt overwogen of dat hiermee geëxperimenteerd wordt. Door gebrek aan elasticiteit van het huidige materiaal, die een canvas wel heeft, komt de replica statisch en minder geloofwaardig over (Benno Tempel ,Gemeentemuseum Den Haag) refereerde hiernaar als het 'surfplankeffect'). Wanneer dit mogelijk is, dan zou deze techniek ook meer inzetbaar zijn voor restauratieve doeleinden, aangezien een meer gelijkende replica een beter beeld kan geven van wat mogelijke ingrepen zouden veroorzaken. Wat de kosten hiervan zijn is mij onbekend en hoeveel deze ontwikkeling voor de kunstwereld zou opleveren is tot nu toe evenmin onderzocht.

Vanuit de professionals werd er benadrukt dat het van belang is dat de ethische kwestie rondom de introductie van deze replicatietechniek wordt onderzocht en dat daarnaast de mogelijke -ethisch geoorloofde- manieren waarop deze techniek kan worden gebruikt, worden geëxploreerd. Er wordt opgemerkt dat er naast veel interesse ook discussie wordt opgeroepen door de introductie van deze techniek, aangezien het onvermijdelijk is dat replica's in omloop zullen komen en dat deze gebruikt zullen worden voor verschillende doeleinden. Het is van belang dat hier aandachtig naar wordt gekeken, zodat men duidelijk voor ogen heeft wat de mogelijkheden zijn en hoe er met deze techniek en toekomstige vergelijkbare technieken omgegaan kan worden. Ook is het van belang dat er wordt onderzocht wat er op lange termijn gebeurt met het polymeer waarvan de prints zijn gemaakt en hoe dit reageert op het materiaal van het kunstwerk dat met deze techniek gerestaureerd zal worden.

Mijn advies is daarom om een deskundige in te zetten om de reactie van het materiaal op lange termijn te onderzoeken en om op deze wijze een passende en reversibele manier van restaureren te creëren. Daarnaast adviseer ik door middel van literatuurstudies en een kwantitatief groter onderzoek na te gaan hoe er (mondiaal) op de 3D-techniek wordt gereageerd. Ook zou er via literatuuronderzoek vastgesteld moeten worden welke mogelijkheden het gebruik van replica's biedt binnen de huidige tentoonstelling-en restauratie-ethiek.

Daarnaast is het wellicht interessant om te investeren in onderzoek naar de rol die 3D-facsimiles van kunstwerken kunnen vervullen voor de marketing van musea. Door als het ware deze facsimiles in te zetten in andere musea zouden deze als promotie kunnen fungeren voor het museum waar het origineel hangt. Hierdoor kan de verspreiding van replica's de angst voor

het verliezen van waarde van het origineel veranderen in een versterking van verlangen om het origineel in het museum te gaan zien. Dit moet echter wel met musea in overleg gebeuren, zodat ook duidelijk wordt waar het copyright ligt en aan welke criteria zij de facsimile's willen laten voldoen.

Hiervoor zal een (grootschalig) marktonderzoek gestart moeten worden naar de mogelijke waarde van de facsimiles wanneer deze op de markt komen, waarin het productieproces wordt afgewogen tegen het animo en het bedrag dat de koper wil besteden aan de kopie. Facsimiles inzetten voor marketingdoeleinden zou een mogelijkheid zijn om het printen van 3D-/2,5D-replica's rendabel te maken. Er moet echter wel in overweging worden genomen in welke mate en op welke schaal het printen is toegestaan, zodat het nog ethisch en moreel verantwoord is tegenover het origineel en het museum dat de originele werken in zijn collectie heeft

3. Aanbevelingen

Aan de hand van de interviews en de uitkomsten hiervan kan er geconstateerd worden dat er veel aandacht en interesse is voor de introductie en het gebruikt van 3D-/2,5D-print binnen de kunsten en de restauratie van kunstwerken. Op basis van mijn onderzoek heb ik de volgende aanbevelingen:

- Onderzoeken welke mogelijkheden er zijn om kopieën in te zetten ten gunste van het originele kunstwerk;
- Ontwikkelen van gebruiksvriendelijke software en een goedkope manier van printen ontwikkelen voor restaurators en conserveringsmedewerkers om 3D-replicatie voor hen makkelijk inzetbaar te maken;
- Ontwikkelen van manieren om 3D-replicatie in te zetten als een documentatiemiddel (bijvoorbeeld als conditierapporten);
- Onderzoeken wat de reactie van het materiaal van de 3D-prints op lange termijn is en hoe het materiaal op een reversibele manier aangebracht kan worden op een geschilderd oppervlak;
- Ontwikkelen van meer transparantie van het materiaal waaruit 3D-prints bestaan om beter olieverf na te kunnen bootsen;
- Exploreren van de materialiteit van de 3D-print en de eventuele mogelijkheden om textuur te printen op flexibelere ondergronden;
- Bekijken van de tentoonstellings- en educatieve mogelijkheden die ontstaan door de introductie van 3D-techniek;
- Exploreren van de ethische kwestie rondom de introductie van 3D-replicatie en de mogelijke ethisch geoorloofde manieren waarop de techniek gebruikt kan worden. Hierdoor kan er een schatting worden gemaakt hoe er met deze en toekomstige reproductietechnieken omgegaan moet worden;
- Analyseren naar de rol van 3D-facimiles voor de marketing van musea en andere culturele instellingen;
- Starten van marktonderzoek naar de mogelijke waarde van 3D-facimiles op de kunstmarkt en of verkoop ervan rendabel is door het vraag-en aanbod van deze reproducties te bekijken;
- Onderzoek naar de beeldrechten en het copyright van 3D-replica’s.

Bronnen

Barassi, S.; Barger, M.; Beerkens, L.; “Inherent Vice: The Replica and its Implications in Modern Sculpture Workshop” , *Tate Papers*, London: Tate Publishing, 8 (2007)

Elkhuizen, W., *Topographical scanning and reproduction of near-planar surfaces of paintings,* San Francisco: SPIE, 2014

Elkhuizen, W., *Reproducing oil paint gloss in print for the purpose of creating, reproductions of Old Masters*, San Francisco: SPIE, 2014

Appendix 1. Questionnaire- Template questionnaire en Interviews (PDF)
Appendix 2. Uitkomsten interviews (Excel)

Participerende instellingen:

- Boijmans van Beuningen, Rotterdam
- Bonnefantemuseum, Maastricht
- Frans Hals Museum, Haarlem
- Gemeentemuseum, Den Haag
- Hermitage, Amsterdam
- Kunsthal, Rotterdam
- Maaike Roozeburg Studio, Amsterdam
- Mauritshuis, Den Haag
- Rijksmuseum van Oudheden, Leiden
- Rijksmuseum, Amsterdam
- Stichting Rijksatelier Limburg (SRAL), Maastricht
- van Abbemuseum, Eindhoven
- Van Gogh Museum, Amsterdam
- Wereldmuseum, Rotterdam

Appendix 4. Interview results *The Girl in the Spotlight*

Nummer	1. Bent u bekend met 3D-printen en de mogelijkheden hiervan? Ja/Nee	1a. Welke manieren van 3D-printen kent u?	2. Wat is uw houding tegenover replica's? Positief/Negatief	3. Wat vindt u van de kwaliteit van de print? Goed/Neutraal/ Slecht	4. Vindt u dat de 3D-replica op deze manier bruikbaar is? Ja/Nee	5. Denkt u dat de replica schade doet aan de authenticiteit van het origineel? Ja/Nee	5a. Waarom wel/niet?	6. Zou u vaker replica's toestaan in tentoonstellingen? Ja/Nee	6a. Waarom wel/niet en op welke manier?
1	Ja	Het printen van organen, verder onbekend.	Positief	Goed	Ja	Nee	De print vervult een functie dat de originele niet kan op het moment. Het is wel goed dat de echte er wel nog is, dat maakt het wat acceptabeler	Ja	Misschien aanraken, of als een kunstwerk niet op zaal is door restauratie o.i.d.
2	Ja	Sinds vandaag dat er schilderijen worden geprint, maar ik wist wel dat er plastic figuren werden gemaakt	Positief	Goed	Ja	Nee	Nee, want de print helpt hier het origineel	Ja	Als het een educatief doel heeft of iets doet wat het origineel niet kan, zoals dat hier is.
3	Nee	Vandaag is de eerste keer dat ik het zie, verder had ik er wel van gehoord maar wist ik niet wat het inhield.	Positief	Goed	Ja	Ja	Ik vind dat een museum echte kunstwerken moet laten zien	Nee	Zie antwoord 5a.
4	Ja	Ik heb eens een ge-3Dprint koekje gegeten, verder weet ik van celprinten.	Positief	Goed	Ja	Nee	Ik vind het ten eerste heel bijzonder hoe goed de replica is en ten tweede is het heel educatief ingezet, en niet als een origineel	Ja	Aanraken, educatief, uitvergroot misschien.
5	Ja	Het printen van organen.	Negatief	Goed	Ja	Nee	De print is overduidelijk een replica volgens het bordje eronder, dus ik denk niet dat mensen het zullen verwarren met de echte.	Ja	Waarom niet. Als er wel wordt aangegeven dat het een replica is.
6	Ja	Ik wist wel dat ze het Joodse bruidje ooit hadden geprint, verder ken ik het van organen.	Negatief	Neutraal	Ja	Ja	De print is niet van goede kwaliteit en doordat het is ingelijst en in een museum staat kan het zijn dat mensen het verkeerde schilderij als het echte zien.	Nee	Zie antwoord 5a.
7	Ja	Allerlei dingen, maar ik wist niet dat schilderijen geprint werden.	Positief	Goed	Ja	Nee	Nee, want de print helpt hier het origineel. Toevoeging: het origineel is er nog, dus je voelt nog de aanraking met de echte.	Ja	Ik denk dat het heel leuk is voor kinderen of slechtzienden om kunst aan te raken. Daarnaast, iedereen wil kunstwerken stiekem wel aanraken toch?
8	Ja	Vanalles: industriële onderdelen; plastic poppetjes.	Positief	Goed	Ja	Nee	Nee, want de print helpt hier het origineel	Ja	In dit soort gevallen als in deze tentoonstelling. Wanneer het een toevoegende rol heeft ten gunste van het origineel

9	Ja	Ik heb zelf een 3D-printer	Positief	Neutraal	Ja	Nee	Er staat heel duidelijk dat het een replica is, dus er is geen verwarring mogelijk. Daarnaast helpt het wel om dichter bij het origineel te kunnen komen. Het echte gevoel is toch wel een soort van in de ruimte doordat het origineel op de achtergrond wordt 'genezen'	Ja	Als de kunstwerken wat beter zijn is het misschien leuk om de originele kleuren te demonstreren. Verder lijkt aanraking me wel interessant.
10	Ja	Via een documentaire op Netflix weet ik dat er plastic wordt geprint.	Positief	Neutraal	Ja	Nee	Het is overduidelijk een replica en dat is ook zo aangegeven.	Ja	Misschien bruikleen of om kunstwerken die niet uitgeleend worden tentoon te stellen
11	Ja	Het printen van organen, verder onbekend.	Positief	Goed	Ja	Nee	De print zorgt ervoor dat je dichterbij kan komen dan ooit. Je voelt echt een connectie met het origineel dat in de kamer wordt onderzocht.	Ja	Als het ten gunste is van het schilderij en het niet als een kunstwerk wordt opgehangen. Er moet wel een groot bordje bij dat het om een kopie gaat
12	Ja	Ik weet van het printen van schilderijen via de krant en tv, verder weet ik dat het voor allerlei dingen wordt gebruikt.	Positief	Neutraal	Ja	Nee	De print mist de glans en diepgang die het origineel heeft. Wel denk ik dat de print hier het origineel helpt en bewaakt, doordat de replica ervoor zorgt dat je een beeld kan vormen bij het origineel dat geblokkeerd is door machines	Nee	Ik denk dat het niet houdbaar is, ik denk dat mensen toch echt originele werken willen zien en de lol hier wel vanaf gaat.
13	Ja	Organen, plastic onderdelen.	Positief	Goed	Ja	Nee	Het is een heel indrukwekkende replica, ik denk dat het op deze manier de band met de authenticiteit van de echte versterkt doordat je dichterbij kan komen dan ooit.	Ja	Aanraken, uitvergroten.
14	Nee	Ik ben niet heel bekend met moderne technologie, ik wist van de term, maar ik wist niet dat dit mogelijk was.	Positief	Goed	Ja	Ja	Het is een leuk 'speeltje' voor een keer, maar ik vind dat er in een museum echte kunstwerken moeten zijn. Het is heel verwarrend dat er twee worden gedemonstreerd in een lijst alsof ze allebei echt zijn.	Nee	Zie antwoord 5a.

15	Ja	Organen, sinds vandaag ook kunst	Positief	Goed	Ja	Nee	Het gevoel van de echte is er nog doordat deze in de ruimte is, maar die wordt alleen maar meer versterkt doordat de kopie je nog dichterbij laat komen	Nee	Ik denk dat het alleen kan als het origineel er is en als het een functie vervult als deze, maar dit soort uitgebreide onderzoeken zijn natuurlijk vrij zeldzaam. Ik denk niet dat het nog heel veel gaat gebeuren.
16	Ja	Plastic onderdelen	Positief	Goed	Ja	Nee	Het werkt hier in dienst van het origineel als een onderwijzend iets.	Ja	Mij lijkt aanraken heel leuk om een museum toegankelijker te maken. Ik denk wel dat het voor gebruiksvoorwerpen nuttiger is om deze te kopieren dan schilderijen
17	Ja	Organen, plastic onderdelen.	Positief	Goed	Ja	Nee	Nee, want de print helpt hier het origineel. Toevoeging: het origineel is er nog, dus je voelt nog de aanraking met de echte.	Ja	Overzichttentoonstellingen, maar dan wel duidelijk maken dat er nepperts tussen zitten.
	(88.2%): ja (11.8%): nee		(88.2%): positief (11.8%): negatief	(82.4%): goed (17.6%): neutraal (0.0%): slecht	(100.0%): ja (0.0%): nee	(17.6%): ja (82.4%): nee		(70.6%): ja (29.4%): nee	

Appendix 5. Interview – restoration of *De Toren van Babel* replica

Vragen Liselore Tissen aan Eva van Zuilen
Restauratie van de 110 % reproductie van de *Toren van Babylon*
Boijmans van Beuningen, Rotterdam
26 februari 2018

Beste mevrouw van Zuilen,

Ik heb u benaderd in het kader van mijn afstudeeronderzoek naar de toepasbaarheid van 3D-replicatie voor de conservering van kunst en hoe de introductie van gelijksoortige reproducties van invloed is op onze perceptie van kunst. Het onderzoek is opgezet vanuit een samenwerking van Universiteit Leiden onder begeleiding van prof. dr. C.J.M. Zijlmans met het team van prof. dr. J. Dik, Technische Universiteit Delft dat zich bezighoudt met het vervaardigen, onderzoeken en optimaliseren van het repliceren van kunstwerken door het gebruik van 3D print-technieken. Mijn laatste hoofdstuk is gewijd aan de vraag of (3D)-reproducties op ten duur ook een vorm van authenticiteit krijgen en het dus waard worden gevonden om gerestaureerd te worden.

Het interview vond op 26 februari 2018 plaats in het restauratie atelier van het museum Boijmans van Beuningen in Rotterdam. De restauratie werd uitgevoerd door de particuliere restaurator vroegmoderne schilderkunst Eva van Zuilen.

Wat is in eerste instantie uw reactie/gedachte over het bestaan van deze reproductie?

De restaurator vindt het bijzonder dat deze reproducties bestaan en worden tentoongesteld in musea. Daarbij is het belangrijk dat deze reproductie zonder lijst op een kale muur hangt, waardoor de illusie dat dit een echt kunstwerk is zoveel mogelijk wordt verbroken. Het laatste wordt door de restaurator als zeer belangrijk bevonden.

Heeft u eerder replica's of reproducties van schilderijen gerestaureerd?
Zo ja, waren deze vervaardigd met een gelijksoortige reproductietechniek? Was het een reproductie van een overeenkomende casus waarbij het origineel op reis was?

De restaurator heeft dit nog nooit eerder meegemaakt en beschouwt deze casus als een uitzonderlijke situatie.

Wat denkt u dat ervoor heeft gezorgd dat de reproductie beschadigd is?

De oorzaak is onbekend, maar dit is vermoedelijk door handelen voor of na transport gebeurd. Het is in ieder geval niet op zaal gebeurd.

Is het materiaal waarvan de reproductie gemaakt is een duurzaam materiaal?

Het materiaalgebruik in het geval van deze replica is dichtbij het originele materiaalgebruik (zelfde houten ondergrond, onderlaag is wit); alleen de bovenste laag en het reliëf zijn significant anders (inkjet op papier). Hoe dit materiaal op lange termijn verandert is niet bekend bij de restaurator.

Wat is uw gedachte over het restaureren van een reproductie van een schilderij?

De restaurator geeft aan dat er een duidelijk verschil moet worden gemaakt tussen grondige restauratie en het wegwerken van een schade. Het laatste is het geval bij de reproductie, waardoor de restaurator begripvol tegenover de opdracht staat. De restaurator zegt dat het goed is dat de schade wordt weggewerkt, want het springt in het oog en zorgt daardoor voor een verstoring van het beeld. De manier van restaureren wordt vergemakkelijkt doordat de restaurator het origineel heeft om vanaf te kijken.

Denkt u dat een volledige reproductie een manier van schilderijen restaureren is of kan zijn?

Niet volledig, fragmentarisch zou het eventueel wel toepasbaar kunnen zijn.

Denkt u dat reproductietechnieken zoals 3D-print een middel kan zijn om de restauratie van originele kunstwerken te bevorderen (door de reproductie bijvoorbeeld te gebruiken om restauratieve ingrepen op uit te voeren alvorens op het origineel over te gegaan of om stukken reproductie te gebruiken om lacunes te retoucheren) Zo ja, op welke manier zou de techniek inzetbaar zijn volgens u?

Om samples te maken ter toetsing van restauratieve ingrepen.

Zo nee, waarom denkt u van niet?

Voor het maken van retouches zijn er klassieke middelen (silicone mallen) die tot nu toe zeer effectief zijn. De restaurator ziet er daarom voorlopig geen baat bij om hier 3D-print voor te gebruiken.

Denkt u dat reproductietechnieken zoals 3D-print een middel kan zijn om de conservering van originele kunstwerken te bevorderen (door bijvoorbeeld reproducties te maken van de huidige staat van het kunstwerk waaraan later degradatie getoetst kan worden of door een reproductie te laten reizen in plaats van het origineel dat te fragiel is op transport te doen)?
Zo ja, op welke manier zou de techniek inzetbaar zijn volgens u?

Zo nee, waarom denkt u van niet?

Digitale reproductie en fotografie zijn tot nu toe nuttiger en accurater als conditierapport, dus voor nu ziet de restaurator hier geen toepasbaarheid in.

Denkt u dat het inzetten van reproducties zoals de *Toren van Babylon* een goede manier is om een tentoonstelling of collectie aan te vullen?

Als educatief middel is het interessant, maar om een collectie aan te vullen met een reproductie gaat een stap te ver.

Vindt u het meer acceptabel om bijvoorbeeld sculpturen of architectuur te reproduceren dan schilderijen?
Waarom wel/ waarom niet?

Ja, mits het origineel wordt geconserveerd.

Denkt u dat reproductie met 3D-print in de toekomst gebruikt zal worden?

Wellicht om er restauratieve oefeningen op te doen. De 3D-informatie die wordt vergaard om een kunstwerk te printen is interessanter om te gebruiken en te bewaren dan een fysieke 3D print zelf.