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Indistinguishable Likeness: the impact of the original artwork and its 3D-printed twin on the discipline of art history, conservation, and museum practice

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GLOSSARY

Term	Definition
3D Digital Microscopy	A digital recording and research technique based on optical microscopy uses a digital camera instead of an eyepiece to display the digitally obtained image directly. ¹
3D printing / additive manufacturing (AM) / rapid prototyping (RP)	A manufacturing technique that uses a digital model and the deposition of small, fused layers of material to form a three-dimensional object.
Affect	A subconscious and intuitive bodily experience that does not contain meaning and instantaneously occurs through the energetic transmission between agents.
Agency	The ability to act, choose what action to take, and provoke action or behavior.
Agent	A (non)living being that has the power to influence and affect other actors through the position and interaction within an extensive (social) network.
Allographic	A term introduced by Nelson Goodman (1968) refers to artworks with various equally authentic manifestations rather than one physical autographic version, such as music and literature. ²
Artificial Intelligence (AI)	All machines or computers that mimic human cognitive functions, such as learning, reasoning, and problem-solving.
Aura	A word used by Walter Benjamin (1936) to describe an artwork's appeal to the viewer produced by its materiality that symbolizes a distinct historical moment (authenticity) with a predetermined purpose within a specific context (cult-value). ³

All sources referenced below have been integrated into the list of references of this book (370-402)

¹ "Digital Microscopy," Art & Architecture Thesaurus - Getty Research, 2023, Accessed 01 July 2024, <https://www.getty.edu/vow/AATFullDisplay?find=digital+microscopy>.

² N. Goodman, *Languages of Art: An Approach to a Theory of Symbols* (Indianapolis: Hackett, 1968), 110-13.

³ W. Benjamin, *The Work of Art in the Age of Mechanical Reproduction*, trans. J. A. Underwood (London: Penguin UK, 1936), 14–16.

Authentication	The act of confirming the originality or trustworthiness of objects and artists by retracing their provenance through their materials. ⁴
Authenticity	The fact or quality of being true, authentic, real, or in accordance with fact; veracity; correctness. ⁵
ahistoric - / anachronistic -	A subdivision of conceptual authenticity defined by Nicole Ex (1993) and Alois Riegl (similar term: "Stilreinheit", 1903) where the passage of time and the possible material decay that is essential to the artist's concept and the validity of an artwork's materials is disregarded, countered, or reversed to some degree to save some of the artwork's materials. ⁶
conceptual -	A type of authenticity where the genuineness of the artwork depends on the correspondence with the initial concept or idea of the artist (similar term: "Kunstwerth", Riegl, 1903). ⁷
experiential -	A type of authenticity attributed to the embodied experience that something is or feels authentic is evoked through material things and active multi-and social interaction. ⁸
expressive -	A type of authenticity defined by Dennis Dutton (2005) where validity is found in an object's materials irreplaceability determined by an individual's or society's values, subjective factors, and (individual) experience. ⁹

⁴ J. Penrose, "Authenticity, Authentication and Experiential Authenticity: Telling Stories in Museums," *Social & Cultural Geography* 21, no. 9 (2020).

⁵ "Authentic, Adj. & n.," in *Oxford English Dictionary* (Oxford: Oxford University Press, September 2023), *Oxford English Dictionary*; "Authentic, Adj., Sense 7.a," in *Oxford English Dictionary* (Oxford: Oxford University Press, September 2023), *Oxford English Dictionary*; "Authentic, Adj., Sense 8," in *Oxford English Dictionary* (Oxford: Oxford University Press, September 2023), *Oxford English Dictionary*; "Authenticity, n.," in *Oxford English Dictionary* (Oxford: Oxford University Press, September 2023), *Oxford English Dictionary*.

⁶ A. Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, Reprint 2014 (Whitefish: Literary Licensing LLC, 1903), 23–29; N. Ex, *Zo Goed Als Oud: De Achterkant van Het Restaureren*, ed. E. van de Wetering (Amsterdam: Amber, 1993), 94–96, 115–23; D. Lowenthal, *The Past Is a Foreign Country - Revisited* (Cambridge: Cambridge University Press, 2015), 229–33.; D. Lowenthal, "Counterfeit Art: Authentic Fakes?," *International Journal of Cultural Property* 1 (1992): 125–27.

⁷ Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, 23–29; Ex, *Zo Goed Als Oud: De Achterkant van Het Restaureren*, 94–96, 115–23; Lowenthal, *The Past Is a Foreign Country - Revisited*, 229–33.; Lowenthal, "Counterfeit Art: Authentic Fakes?," 125–27.

⁸ Penrose, "Authenticity, Authentication and Experiential Authenticity," 1252, 1258–61.

⁹ Dutton, "Authenticity in Art," 258–60.

functional - / contextual -	A type of authenticity found in the correct function and displaying it in the environment that properly belongs to the artwork (similar term: "Gebrauchswerth", Riegl, 1903). ¹⁰
haptic -	A type of authenticity found in the tactile or haptic validity of an artwork.
historic -	A subdivision of conceptual authenticity defined by Nicole Ex (1993) and Alois Riegl (similar term: "Stilreinheit", 1903) where the passage of time and the possible material decay that comes with it is essential to the realization of the artist's concept and the validity of an artwork's materials. ¹¹
material -	A type of authenticity granted to the validity of the historicity of materials, techniques or ideas of which the provenance can be retraced through material research (similar term: "Erinnerungswerth", Riegl, 1903).
nominal -	A type of authenticity defined by Dennis Dutton (2005) where validity is found in the historicity of the artwork's materials' origins, authorship, or provenance. ¹²
Autographic	A term introduced by Nelson Goodman (1968) to refer to art forms where only one or a limited number of autograph(s) or material version(s) comprises the work of art, such as painting, sculpture, and architecture. ¹³
Binder Jetting (BJT)	A manufacturing method where droplets of liquid ink(s) made with powdered materials are deposited and solidified with a liquid bonding agent. ¹⁴
Calotype	A photographic technique developed in 1851 by William Henry Fox Talbot (1800–1877) where writing paper is sensitized with silver nitrate and potassium iodide to produce light-sensitive

¹⁰ Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, 23–29; Ex, *Zo Goed Als Oud: De Achterkant van Het Restaureren*, 115.; Lowenthal, "Counterfeit Art: Authentic Fakes?," 125–27.

¹¹ Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, 23–29; Ex, *Zo Goed Als Oud: De Achterkant van Het Restaureren*, 94–96, 115–23; Lowenthal, *The Past Is a Foreign Country - Revisited*, 229–33.; Lowenthal, "Counterfeit Art: Authentic Fakes?," 125–27.

¹² Dutton, "Authenticity in Art," 258–60.

¹³ N. Goodman, *Languages of Art: An Approach to a Theory of Symbols* (Indianapolis: Hackett, 1968), 110–13.

¹⁴ "ISO/ASTM 52900:2021(En), Additive Manufacturing — General Principles — Fundamentals and Vocabulary," 3.2.1., Accessed 9 March 2024, <https://www.iso.org/obp/ui/#iso:std:iso-astm:52900:ed-2:v1:en>.

	silver chloride. Exposure to intense light (sun) allowed the user to produce several positive prints. ¹⁵
Computed tomography (CT)	A material recording method that utilizes X-rays to take a sequence of radiographs from various angles while rotating around the object. An object's interior and exterior can be visualized in grayscale based on density. ¹⁶
Computer-aided design (CAD)	A digital model defined by geometrical parameters. ¹⁷
Computer-aided manufacturing (CAM)	A computational manufacturing method that materializes a three-dimensional digital CAD design. ¹⁸
Conservation	The methods, activities, and procedures (including preservation and restoration) that maintain the aesthetic integrity of a piece of art protect tangible cultural legacy and ensure it is accessible to present and future generations. ¹⁹
Copy	The umbrella term for all objects that result from copying (usually by someone or something other than the original artist). The copy is a realization of an artwork that utilizes the original as a signal; hence, differences in materials and visual similarity may occur. ²⁰
Counterfeit	A fabricated, unauthorized copy of an existing authentic artwork to pass as the original. ²¹
Cross-section fluorescent staining /	A material investigation process in which fragments of an artwork's material are implanted in polyester resin to identify

¹⁵ C.A.P. Willsdon, F. Stafford, and C. Payne, *'Painting and Photography', in Pegwell Bay, Kent – a Recollection of October 5th, 1858–60 by William Dyce*, In Focus (London: Tate Research Publication, 2016).

¹⁶ S. Legrand et al., "Examination of Historical Paintings by State-of-the-Art Hyperspectral Imaging Methods: From Scanning Infra-Red Spectroscopy to Computed X-Ray Laminography," *Heritage Science* 2, no. 13 (2014).

¹⁷ "ISO 18739:2016(En), Dentistry — Vocabulary of Process Chain for CAD/CAM Systems," Accessed 9 March 2024, <https://www.iso.org/obp/ui/#iso:std:iso:18739:ed-1:v1:en>.

¹⁸ Idem.

¹⁹ "Conservation Terminology," American Institute for Conservation, 2023, Accessed 1 April 2024, <https://www.culturalheritage.org/about-conservation/what-is-conservation/definitions>.

²⁰ L.N.M. Tissen and M. van Veldhuizen, "Picture-Perfect - The Perception and Applicability of Facsimiles in Museums," *Art and Perception*, 2022, 9.

²¹ M. Carrara, "Are Counterfeits Copies?," in *The Aesthetics and Ethics of Copying*, ed. D.H. Hick and R. Schmücker (New York City: Bloomsbury Publishing, 2016), 111–16.

paint sampling	and investigate the different material layers of a painting's materials under a microscope. ²²
Cultural turn / affective turn	A movement in the humanities and social sciences (since 1995) that showed an increased interest in art's cultural, anthropological, and epistemological qualities of objects, images, art, and (non-) organic beings beyond their representation. ²³
Daguerreotype	Louis Daguerre (1787-1851) invented a photographic technique in 1841 that made silver-plated copper light-sensitive by treating it with mercury. Exposure to (sun)light allows for the photograph to be taken.
Deep learning	A subfield of machine learning, a type of neural network that processes data through at least three (sometimes hidden) layers of code before formulating a response.
geometric -	A type of deep learning where Euclidean space is transferred to non-Euclidean domains to generate three-dimensional information. ²⁴
Dendrochronology	A scientific method for dating wood by counting the three rings. ²⁵
Diffusion model	A neural network that denoises photos blurred by Gaussian noise by filling in missing information using previously encountered image descriptions and textual cues.
Digitalization	The process of making digitized assets workable or effective through conversion.
Digitization	The conversion from an analog format to a digital version.

²² "Cross Sections," Art & Architecture Thesaurus - Getty Research, January 1, 2023, Accessed 01 July 2024, <https://www.getty.edu/vow/AATFullDisplay?find=cross-section>

²³ G. Deleuze and F. Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia*, Bloomsbury Revelations Series (New York: Bloomsbury, 2013).

²⁴ Euclidian - the study of angles and shapes formed by the relationships between lines to calculate the three dimensionality in space - Bronstein, M. M. et al. Geometric Deep Learning: Going beyond Euclidean Data. In: IEEE Signal Processing Magazine. vol. 34. no. 4. 2017. 18–42.

²⁵ Dendrochronology," Art & Architecture Thesaurus - Getty Research, 2023, Accessed 1 March 2024, <https://www.getty.edu/vow/AATFullDisplay?find=dendrochronology>.

Direct Energy Deposition (DED)	An additive manufacturing method that uses melted (powdered) metal that is dispositioned and hardened to construct a three-dimensional object. ²⁶
Duplicate	An identical copy that corresponds exactly to one single original in terms of materials and visual features, allowing no variations of any kind. A duplicate can function as a valid replacement of the original.
Elevated printing	An additive manufacturing method / type of material jetting (MJ) developed by Canon Production Printing where a photocurable curable ink is deposited on a flat surface that is hardened with a UV-light to create polychrome textured surfaces. ²⁷
Emotion	The short-lived subconscious internal bodily response and cognitive reaction to external stimuli. The experienced emotions and behavioral responses are situational and contextual and precede conscious recognition of a feeling. ²⁸
Empathy	The recognition and embodied experience of the emotions and perspectives of another agent. ²⁹
Engraving	A traditional printing technique where a pattern is carved on a copper plate with a hardened steel tool. ³⁰
Etching	A traditional printing technique where a depiction is scratched into a wax layer on a copper plate. The design is fixed on the plate by pouring acid on the exposed copper. ³¹
Euclidean	The study of points, lines, angles, surfaces, and solids based on Euclid's axioms used to describe flat two-dimensional space. A space in which points are designated by coordinates (one for each dimension) and the distance between two points is given by a distance formula. ³²

²⁶ K. Deshmukh et al., "Introduction to 3D and 4D Printing Technology: State of the Art and Recent Trends," in *3D and 4D Printing of Polymer Nanocomposite Materials*, ed. K. Deshmukh, K.K. Sadasivuni, and M.A. Almaadeed (London: Elsevier, 2020), 7.

²⁷ "Elevated Printing," Project Eiger, accessed April 5, 2021, <https://www.projecteiger.com/>.

²⁸ S. Magsamen and I. Ross, *Your Brain on Art: How the Arts Transform Us* (Edinburgh: Canongate Books, 2023), 31.

²⁹ Magsamen and Ross, *Your Brain on Art: How the Arts Transform Us*, 172–75.

³⁰ H. Westgeest et al., *Kunsttechnieken in Historisch Perspectief*, 171–72.

³¹ *Ibid.*, 172–74.

³² The Editors of Encyclopaedia Britannica, "Euclidean Geometry Summary," Encyclopaedia Britannica, February 5, 2003, Accessed 1 May 2024,

	non -	A type of geometrical data that does not obey Euclidean postulates. The distance between two points is not seen as straight but curved or hyperbolic and the number of lines is infinite and not necessarily symmetrical. It describes three-dimensional or curved surfaces (e.g., 3D meshes). ³³
Facsimile		A term derived from the Latin fac simile, 'make alike', a close copy of the original artwork in terms of its essence and aesthetic value in newer materials. ³⁴
Fake		A copy that aesthetically mimics a well-known original artwork or artist's style and is associated with deliberate falsification of the provenance of the object or author in a way that is cheap, fast, or low effort.
Feeling		The instantaneous and conscious interpretation of emotions and sensory experiences based on past experiences, and cultural and social conventions.
Forgery		The deliberate falsification of an artist's process of creation to introduce new artworks that falsely pass of as if they were made by the original artist that is being forged.
Gaussian	- noise	A digital distortion that occurs due to some form of limitation during (digital) image acquisition (e.g., lighting, a broken image sensor or interference during the transmission of the image).
	- splatting (3DGS)	A conventional computer graphics approach that creates 2D image pixel values that retain 3D by filling in missing information in a point cloud of a 2D image or video using the normal distribution of multiple pictures of the same object, video, or previously learned images. ³⁵

<https://www.britannica.com/summary/Euclidean-geometry>; The Editors of Encyclopaedia Britannica, "Euclidean Space," Encyclopedia Britannica, March 22, 2024, Accessed 1 May 2024, <https://www.britannica.com/science/Euclidean-space>.

³³ The Editors of Encyclopaedia Britannica, "Non-Euclidean Geometry Summary," Encyclopedia Britannica, February 5, 2003, Accessed 1 May 2024, <https://www.britannica.com/summary/non-Euclidean-geometry>; D. Taimina and D.W. Henderson, "Non-Euclidean Geometry," Encyclopedia Britannica, March 15, 2024, Accessed 1 May 2024, <https://www.britannica.com/science/non-Euclidean-geometry>.

³⁴ T. Lenain, *Art Forgery: The History of a Modern Obsession* (London: Reaktion Books, 2012), 36–41.

³⁵ Z. Wang et al., "NeRF--: Neural Radiance Fields without Known Camera Parameters," *arXiv*, no. Preprint 2102.07064 (2021).

Generative Pre-trained Transformer (GPT)	A type of open-source artificial intelligence that consists of neural network models that give applications the ability to directly generate human-like text and content (e.g., images, music), and answer questions in a conversational manner (e.g., ChatGPT).
Haptic	A term introduced by Max Dessoir (1892) to refer to a way of exploring the world around us through the sense of touch. ³⁶
- <i>looking</i>	A term introduced by Laura U Marks (2002) to refer to a form of visual perception where depicted materials and differences in texture are interpreted and imagined as what they must feel like. ³⁷
- <i>perception</i>	A term introduced by Alois Riegl (1901) defined as "...the combination of tactile, kinesthetic and proprioceptive functions, the way we experience touch both on the surface of and inside our bodies." ³⁸
- <i>visuality</i>	A term introduced by Laura U Marks (2002) to refer to a form of visual perception that is experienced and embodied with all other senses by combining past experiences of touch and kinesthetics while relying on sight alone. ³⁹
Hysteresis effect	A term introduced by Pierre Bourdieu (1983) to refer to dislocation and disruption that occurs between an individual's embodied dispositions and social structures they encounter. This could happen when a social structure or social field's regularities (even the rules) are profoundly changed. ⁴⁰

³⁶ L.U. Marks, "Introduction," in *Touch*, NED-New edition, Sensuous Theory and Multisensory Media (University of Minnesota Press, 2002), 3–6.

³⁷ L.U. Marks, *Haptic Entanglements, Organs of Touch*, interviewed by Rahel Spöhrer and Josua Wicke, interview by R. Spöhrer and J. Wicke, Website, September 1, 2021, Accessed 1 April 2024, <https://www.schauspielhaus.ch/en/journal/20831/haptic-entanglements-organs-of-touch-a-mail-conversation-with-laura-u-marks>; Marks, "Introduction," 3–6.

³⁸ L.U. Marks, *Touch: Sensuous Theory and Multisensory Media* (Minneapolis: University of Minnesota Press, 2002), 2; A. Riegl, *Late Roman Art Industry*, ed. R. Winkes, *Archaeologica* (Rome: G. Bretschneider, 1985), 72–75.

³⁹ Marks, "Introduction," 3–5.

⁴⁰ P. Bourdieu, "The Field of Cultural Production, or: The Economic World Reversed," *Poetics* 12, no. 4 (1983).

Illocution	A term introduced by John L. Austin (1963) to refer to a type of performative (force) that depends on context and conventions, its force is determined by the (in)correct reception of locutions. ⁴¹
Immanence	A term used by Gérard Genette (1997) referring to belonging to the order of ‘being’; manifested in the material world, physical. ⁴²
partial -	A term used by Gérard Genette (1997) referring to the perceived authenticity of artworks when their physical features are partly or absent, invisible, incomplete, or deficient. ⁴³
plural -	A term used by Gérard Genette (1997) referring to the entirety of physical versions that form the artwork’s authenticity because they share the same history of production (e.g., multiple versions of a statue after one cast). ⁴⁴
plurality of - (plurality of effects)	A term introduced by Gérard Genette (1997) to describe a group of closely related autographic artworks or several nonidentical, concurrent objects that, together, make up the artwork. Value is determined by the viewer’s reception, rather than materials. ⁴⁵
Impasto	The thick layers of paint that add three-dimensionality to painted surfaces.
Infrared Radiation (IR)	A section of the electromagnetic radiation spectrum with wavelengths ranging from roughly 700 nanometers (nm) to one millimeter.
- photography (IR photography)	A digital imaging technique that utilizes reflected visible light waves and wavelengths between 700-1100 nm. in the infrared segment of the electromagnetic spectrum. This makes it possible to visualize subsurface layers such as underdrawings in paintings. ⁴⁶

⁴¹ J.L. Austin, *How to Do Things with Words: Second Edition*, ed. J.O. Urmson and M. Sbisà (Boston: Harvard University Press, 1975).

⁴² G. Genette, *The Work of Art*, trans. G.M. Goshgarian, 1 (New York City: Cornell University Press, 1997), 39-41.

⁴³ *Ibid.*, 161–62, 211.

⁴⁴ *Ibid.*, 74–94, 203, 208–10, 161–62.

⁴⁵ G. Genette, *The Work of Art*, trans. G.M. Goshgarian, 1 (New York City: Cornell University Press, 1997), 39-31.

⁴⁶ “Glossary: Infrared,” The National Gallery - Glossary, 2021, Accessed 1 May 2024, <https://www.nationalgallery.org.uk/paintings/glossary/infrared>.

- reflectography (IRR)	A digital imaging technique that uses wavelengths between 900-2500 nm. in the infrared range of the electromagnetic spectrum. Infrared light is absorbed by carbon-rich materials and heavy metals that are reflected from light-colored elements. ⁴⁷
Inherent vice	The (purposeful) self-destruction of an artwork's material. ⁴⁸
Installation art(work)	A large-scale, mixed-media construction, often designed for a specific place or a temporary period. ⁴⁹
Laser scanning	A digital recording technology that calculates three-dimensionality based on the deflection of laser points, patterns, and/or lights and measures the distance between the laser and the scanned sample.
Light detection and ranging (LiDAR)	A remote-sensing technology similar to time-of-flight (ToF) that measures distance based on low-energy laser pulses. Combining these distance points, a three-dimensional digital representation of the targeted objects can be generated.
Lithography	A traditional printing process in which an image is carved in a lime sandstone and worked with a greasy substance to make the ink adhere or repel. ⁵⁰
Living presence response	Reacting to an inorganic artifact as alive, despite knowing it is not. ⁵¹
Locution / constative	A term introduced by John L. Austin (1963) to describe the sensory and factual interpretation of formative elements. ⁵²
Machine learning	A subfield of artificial intelligence that teaches computers to recognize patterns through data and algorithms.
Macro-X-ray fluorescence scanning (MA-XRF / Macro-XRF)	A material examination and visualization method that uses X-ray beams on a designated area to measure the emitted

⁴⁷ "Infrared Reflectography," Art & Architecture Thesaurus - Getty Research, 2017, Accessed 01 July 2024, <https://www.getty.edu/vow/AATFullDisplay?find=Infrared>

⁴⁸ S. Barassi, "Inherent Vice: The Replica and Its Implications in Modern Sculpture Workshop," in *Tate Papers*, ed. M. Barger and L. Beerken, vol. 8 (London: Tate Publishing, 2007).

⁴⁹ "Installation Art," Tate Modern Art Terms, 2023, Accessed 1 March 2024, <https://www.tate.org.uk/art/art-terms/i/installation-art>.

⁵⁰ Westgeest et al., *Kunsttechnieken in historisch perspectief*, 180.

⁵¹ A. Iacobone, "Living Presence Response," *International Lexicon of Aesthetics*, no. Spring (2022).

⁵² Austin, *How to Do Things with Words: Second Edition*, 146–48.

	fluorescence radiation of chemical components such as copper, zinc, and iron. ⁵³
Material Extrusion (ME)	An additive manufacturing method that uses the selective deposition of thermosensitive material (plastic, concrete, organic tissue, food) that is heated through a moving printer and hardens upon exposure to air. ⁵⁴
Material Jetting (MJ)	An additive manufacturing method where multiple inkjet nozzles selectively deposit individual droplets of photosensitive material that are solidified with a UV light. ⁵⁵
Material turn	A movement in the humanities and social sciences (since the mid-1960s) that showed an increased interest in the artwork as an object and the analysis of its materials in a social context.
Matrix	A term used by Nelson Goodman (1968) and Gérard Genette (1997) to refer to a physical template on which a design is formed that allows immediate exact copying. ⁵⁶
Melancholia	A sensory and cognitive process where a past negative experience and its related feelings, emotions, memories, and sensations are recollected and relived.
Memory	The ongoing process of retaining physical and mental impressions that can be recalled, connected, and overwritten when new impressions occur.
Mental impression / mental image	A permanent sensory impression of newly perceived sensory stimuli; a tactile mental concept to link the interpretation and future sensory engagements. ⁵⁷
Monument	A term introduced by Alois Riegl (1903) to refer to an artwork/object with age- and memory value.
Multi Jet Fusion (MJF)	A type of powder bed fusion printing capable of printing in full color and with an extensive variety of (more durable and flexible) materials simultaneously.

⁵³ J. Hill Stoner and R. Rushfield, eds., *Conservation of Easel Paintings*, Routledge Series in Conservation and Museology (London/New York: Routledge, 2020), 317–18.

⁵⁴ "ISO/ASTM 52900:2021(En), Additive Manufacturing — General Principles — Fundamentals and Vocabulary," 2.2.4.

⁵⁵ *Idem*.

⁵⁶ N. Goodman, *Languages of Art: An Approach to a Theory of Symbols* (Indianapolis: Hackett, 1968), 110–113; Genette, *The Work of Art*, 50.

⁵⁷ C. van Eck, *Art, Agency and Living Presence: From the Animated Image to the Excessive Object*, Studien Aus Dem Warburg-Haus (Berlin: De Gruyter, 2015), 70.

Neural network	A type of machine learning aimed at mimicking the human brain by making connections between different data points and learning the most important ones to respond to queries adequately.
Neural Radiance Fields (NeRF)	A neural network developed to measure and predict the continuation of a scene from new viewing directions using incomplete sets of 2D photos from angles and the accompanying positions the images were taken.
Neutron activation audio radiography (NAAR)	A qualitative and quantitative element analysis method invented in 1970, in which exposure to electromagnetic radiation makes it possible to define and locate different radioactive elements (major, minor, or traces) present in a sample.
New materialism	A movement in the humanities and social sciences (since 1990) that showed an increased interest in the return to the artwork as an object and its 'matter' is addressed in a relational, plural, and contingent way and seen as part of a network of constant exchange. ⁵⁸
Nexus	A term introduced by Alfred Gell (1998) referring to the network of social relations to which artworks belong, obtain meaning, and have agency. ⁵⁹
Non-fungible token (NFT)	A digital token of the authenticity of a (digital) item. A blockchain validates and secures the item's unicity and individual owner. ⁶⁰
Nostalgia	A psychological state of missing and longing for something that has passed or has been lost; a sensory and cognitive process where a past positive experience and its related feelings, emotions, memories, and sensations are recollected and relived.
anticipatory -	A type of nostalgia characterized by the premature longing for the past before it completely passes.

⁵⁸ H. Schwartz, *The Culture of the Copy: Striking Likenesses, Unreasonable Facsimiles* (Princeton: Princeton University Press - Zone Books, 2014), 114–18.

⁵⁹ A. Gell, *Art and Agency: An Anthropological Theory* (Oxford: Clarendon Press, 1998).

⁶⁰ L.N.M. Tissen, "Digitale Kunstwerken: Rage of Ravage," *Nemokennislink - Faces of Science* (blog), June 8, 2022, Accessed 1 April 2024, <https://www.nemokennislink.nl/facesofscience/blogs/digitale-kunstwerken-rage-of-ravage/>.

Optical coherence tomography (OCT)	A non-invasive imaging technology that uses light of various wavelengths and their reflection to study depth changes at the microscopical level. ⁶¹
Optical visuality	A type of visual perception that draws from previous visual experiences to relate an image of the artwork to its symbolic power. ⁶²
Original	An object made by a specific artist at a particular moment with a determined purpose or intention of which there is no known identical preceding instance, concept or idea. Its origins can be retraced and verified through its materials and/or archival, provenance, and documentary research or by consulting the artist. ⁶³
Parerga	A concept derived from Jacques Derrida's (1979) <i>parergon</i> , refers to the marginal elements, devices, situations, and entanglements that do not belong to the artwork, yet are integral to the aesthetic experience and meaning. ⁶⁴
Pastiche	A concept derived from the French appropriation of the Italian noun <i>pasticcio</i> , (a pie-filling consisting of unknown ingredients) that refers to a new artwork that refers to or contains iconic elements or of one or various artworks or artists such as style, materials or depicted themes.
Patina	The physical and visual traces of time on an artwork's surface and in its materials, such as craquelure, discolorations, and material deformations.
Perception	The cognitive interpretation of received sensory stimuli involves feeling, sensing, and recollecting memories and emotions. ⁶⁵

⁶¹ "Optical Coherence Tomography," *Art & Architecture Thesaurus* - Getty Research, 2017, Accessed 01 July 2024, <https://www.getty.edu/vow/AATFullDisplay?find=optical+coherence>

⁶² Marks, "Introduction," 3–6.

⁶³ Tissen and van Veldhuizen, "Picture-Perfect - The Perception and Applicability of Facsimiles in Museums," 15–16.

⁶⁴ J. Derrida, "The Parergon," trans. C. Owens, *October* 9, no. Summer (1979). J. Grave et al., eds., *The Agency of Display: Objects, Framings and Parerga* (Dresden: Sandstein Verlag, 2018), 5–7.

⁶⁵ M. Pelowski et al., "Visualizing the Impact of Art: An Update and Comparison of Current Psychological Models of Art Experience," *Frontiers in Human Neuroscience* 10 (2016).

Performative	A term introduced by J.L. Austin (1963) that refers to an utterance that does not simply describe the world but has the effect of change in the world. ⁶⁶
Perlocution	A term introduced by J.L. Austin (1963) to describe a type of performative (force) where meaning is attributed based on previous experiences, feelings, thoughts, and judgments. ⁶⁷
Photogrammetry	A photographic method that records the three-dimensionality of objects by taking pictures from various places and angles (with a minimum of two) with which data points can be plotted to calculate the distance and location of each point in the 3D space.
Point cloud	A set of data points in space to capture and digitize an area or object's three-dimensionality.
Powder bed fusion (PBF)	An additive manufacturing method that deposits droplets of liquid ink(s) via multiple nozzles onto a printer platform and solidifies them with a laser. ⁶⁸
Preservation	All direct acts or measures that help stabilize and control the artwork's underlying materials to avoid damage and changes in the artwork's materials or aesthetic qualities.
preventive -	All indirect acts or measures to avoid damage and changes in the artwork's materials or aesthetic qualities.
Radio Frequency Identity Device (RFID)	A wireless device that uses radio frequencies to transfer, track, and identify data.
Raking Light Photography (RAK)	Photographing an object's surface topography and relief with an oblique light source. ⁶⁹
Readymade	A term first used by Dadaist Marcel Duchamp (1997-1968) to describe works of art he made from manufactured objects. ⁷⁰
Reality	

⁶⁶ Austin, *How to Do Things with Words: Second Edition*, 146–48.

⁶⁷ *Idem*

⁶⁸ "ISO/ASTM 52900:2021(En), Additive Manufacturing — General Principles — Fundamentals and Vocabulary."

⁶⁹ L.N.M. Tissen et al., "Using 3D Scanning to Support Conservation Treatments for Paintings," *Materials Science and Engineering* 949 (2020): 9.

⁷⁰ "Readymade," Tate Modern Art Terms, accessed March 9, 2024, Accessed 1 March 2024, <https://www.tate.org.uk/art/art-terms/r/readymade>.

extended - (XR)	The umbrella term for (digital) technologies that add to or extend the material world by either blending virtual worlds with the real world or by supplying a fully immersive virtual experience. Technologies: AR, VR, MR.
augmented - (AR)	A type of extended reality that directly or indirectly interacts with the user's immediate surroundings by appending minor changes (e.g., adding information through a mobile device) through a digital device.
mixed - (MR)	A type of extended reality that mixes digital content with the real world and reacts, responds, and interacts directly with one's space.
virtual - (VR)	A type of extended reality where the user uses a VR headset and is fully immersed in a virtually created reality that does not exist in the real world and/or is inaccessible or otherwise irreproducible at that place at that very moment spaces.
Reception	The process of receiving sensory stimuli at the moment of interaction. ⁷¹
Reconstruction	A reproduction by someone other than the original artist aims to restore something damaged or lost to its historical or visual state. New and original materials are combined to recreate what's missing, but the reproduction is always an interpretation and can never be an exact copy. New materials are allowed as long as they correspond to the original work as closely as possible.
illusionistic -	A type of reconstruction used to imitate the pictorial effects of a painting by using the original working methods and materials as closely as possible. Pictorial effects and application are an additional concern ⁷²
schematic -	A type of reconstruction used to determine the most probable chemical composition, the material behavior of a pigment/paint, and predict how it may change in the future. Schematic

⁷¹ Pelowski et al., "Visualizing the Impact of Art: An Update and Comparison of Current Psychological Models of Art Experience."

⁷² L.N.M. Tissen, "Authenticity and Meaningful Futures for Museums: The Role of 3D Printing," in *Reinventing Boundaries of Crisis*, ed. L.N.M. Tissen et al., Journal of the LUCAS Graduate Conference 9 (Leiden: Leiden University Libraries, 2021), 94–112; L.N.M. Tissen, "Authenticity vs. 3D Reproduction: Never the Twain Shall Meet?," in *Art's in Society: Academic Rhapsodies*, ed. T. Vergeer et al. (Leiden: Leiden University, 2020), 21–40; Tissen and van Veldhuizen, "Picture-Perfect - The Perception and Applicability of Facsimiles in Museums," 1–25.

		reconstructions have no pictorial reference to a painting but mimic specific layers. ⁷³
Reflectance Transformation Imaging (RTI)		A computational photographic approach to collect surface and color information by taking digital images from a fixed camera position. ⁷⁴
Remake		A new production of an existing object/artwork that is somewhat similar to the original it was derived from regarding its aesthetics and/or materials but created with a different theme or motive (e.g., improvements).
Replica		An additional version of an original that is as close to the original as possible and made with a particular reason, for instance, an educational or historical purpose. In addition, it should be made by the same artist and can function as a 'stand-in' when the original is not around because it is lost, damaged, broken, or no longer in existence. Some variations in style or size are allowed.
	authenticated -	A legitimate second version of an existing object/artwork made by someone sanctioned by the original person who created it.
Reproduction		A reproduction is a visually similar copy of an artwork created using different materials and techniques. It does not require artistic provenance and is made to understand the original and extend its meaning. Minor differences, newer materials and methods are allowed. ⁷⁵
	mass -	The large-scale reproduction based on one model, blueprint or original. This can be continuously produced by an automated process and/or several standardized protocols. ⁷⁶

⁷³ *Idem*.

⁷⁴ Tissen et al., "Using 3D Scanning to Support Conservation Treatments for Paintings."

⁷⁵ D.A. Scott, *Art: Authenticity, Restoration, Forgery* (Los Angeles: Cotsen Institute of Archaeology Press, 2016), 51–58; R. Verhoogt, *Art in Reproduction: Nineteenth-Century Prints After Lawrence Alma-Tadema, Jozef Israels and Ary Scheffer* (Amsterdam: Amsterdam University Press, 2007), 31–38; M. Gale, "Terminology for Further Expansion," Tate Papers, 2007, Accessed 1 March 2024, <https://www.tate.org.uk/research/publications/tate-papers/08/terminology-for-further-expansion>.

⁷⁶ "Mass Production, n.," in *Oxford English Dictionary* (Oxford: Oxford University Press, July 2023), Oxford English Dictionary; "Mass-Produce, v.," in *Oxford English Dictionary* (Oxford: Oxford University Press, July 2023), Oxford English Dictionary.

	<i>mechanical</i> -	A term introduced by Walter Benjamin (1936) describing reproduction methods (e.g., photography) that allow the creation of (unlimited) identical copies based on one model, blueprint or original using technological means. ⁷⁷
Restoration		All improvements made to an artwork's condition to an assumed less damaged state or an earlier appearance. Restoration treatments nearly always imply a (deliberately) noticeable change in aesthetics. ⁷⁸
Sheet Lamination (SL)		An additive manufacturing method that extracts material supplied in sheets or rolls (usually metal and paper) using knives or lasers. The separate sheets are joined and stacked by adding an adhesive (glue) or heat. ⁷⁹
Signal		A model that ignites an intellectual process of realization that presupposes that the viewer can interpret the significance of something based on a set of characteristics.
Stereolithography (SLA)		An additive manufacturing method that uses layering polymers in a cross-sectional manner. ⁸⁰
Structured light scanning (SLS)		A photographic method is to record three-dimensionality by projecting a geometric pattern photographed from different angles. The irregularities and deformations in the projected pattern generate the three-dimensional data. ⁸¹
Tacit knowledge		A type of implicit knowledge that can only be understood by showing, imitating, and reproducing (past) actions.
Thermoluminescence (TL)		A form of luminescence occurs in some minerals when heated (e.g., calcium-containing ceramics such as terracotta).

⁷⁷ Benjamin, *The Work of Art in the Age of Mechanical Reproduction*, 14–16.

⁷⁸ S. Muñoz Viñas, *Contemporary Theory of Conservation*, First published in 2005 (Oxford: Butterworth-Heinemann, 2012), 24–25.

⁷⁹ “ISO/ASTM 52900:2021(En), Additive Manufacturing — General Principles — Fundamentals and Vocabulary,” 2.2.6., Accessed 9 March 2024, <https://www.iso.org/obp/ui/#iso:std:iso-astm:52900:ed-2:v1:en>.

⁸⁰ D.L. Bourell, “Perspectives on Additive Manufacturing,” *Annual Review of Materials Research* 46, no. 1 (2016).

⁸¹ D. Akca et al., “High Definition 3D-Scanning of Arts Objects and Paintings,” in *Optical 3-D Measurement Techniques VIII*, ed. A. Grün and H. Kahmen, vol. 2 (Zürich, 2007); B. Breuckmann, “3-Dimensional Digital Fingerprint of Paintings,” in *19th European Signal Processing Conference* (European Signal Processing Conference, Barcelona: IEEE, 2011); M. Karaszewski et al., “Automated Full-3D Digitization System for Documentation of Paintings,” *Proc SPIE* 8790 (2013).

Time-of-Flight (ToF)	A method to calculate three-dimensionality by measuring the time passed between casting light on the sample's surface and receiving light in the detector.
Topography	The three-dimensional arrangement of physical attributes (such as shape, height, and depth) of a near-flat surface. ⁸²
Transcendence	A state of being that overcomes limitations of the physical and material world; intangible values. ⁸³
Translucency	The quality of allowing light to pass diffusely; is almost transparent.
Transparency	The quality of allowing light to pass entirely; see-through.
Tremolierung	A gilding technique where small pounces are made with a gauge in gold leaf.
Triangulation	A method used to calculate the exact distance between the light source, the sample and the camera and the known angle at which it was placed. Once processed and mapped together, a digital representation of the scanned area can be formed.
Ultraviolet fluorescence photography (UVF)	A photographic method to record the state or condition of artworks using two ultraviolet lamps to visualize induced fluorescence patterns emitted by photosensitive materials. ⁸⁴
Value	age - A value or quality introduced by Alois Riegel (1901) that can be attributed to materials for they symbolize a unique moment, time and past manner.⁸⁵ cult - A term introduced by Walter Benjamin (1936) to describe a unique value or quality attributed to materials and their ritual function within a specific historical context, which can only be understood and experienced by a select and exclusive group.⁸⁶

⁸² The National Gallery - Glossary, "Topography", Accessed 9 March 2024, <https://www.nationalgallery.org.uk/paintings/glossary/topography>.

⁸³ G. Genette, *The Work of Art*, trans. G.M. Goshgarian, 1 (New York City: Cornell University Press, 1997), 161-62.

⁸⁴ Tissen et al., "Using 3D Scanning to Support Conservation Treatments for Paintings." 9.

⁸⁵ Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, 23–29.

⁸⁶ Benjamin, *The Work of Art in the Age of Mechanical Reproduction*, 14–16.

effort -	A value or quality is attributed to the effort made to create something. ⁸⁷
exhibition -	A term introduced by Walter Benjamin (1936) to describe a value or quality resulting from an image's repetition and popularity in society. ⁸⁸
memory -	A value or quality introduced by Alois Riegel (1901) granted by fulfilling humanity's social, psychological, and intellectual needs. ⁸⁹
Vat photopolymerization (VPP)	An additive manufacturing method where liquid photosensitive polymer (resin) is selectively cured and solidified by exposure to UV light. ⁹⁰
Visible Light Photography (VIS)	Photographing method to record the condition of artworks. Two light sources are adjusted to minimize disturbing reflections on the object's surface. ⁹¹
Voxel	The three-dimensional equivalent of a two-dimensional pixel.
Woodblock printing	A traditional printing process where a pattern is carved on wood that is coated with ink and pressed on paper or other surfaces to transfer the image.
X-radiography (X-ray / RAD)	A visualization method for the interior and exterior of objects by applying ionizing radiation to detect material of different densities. ⁹²

⁸⁷ B. Latour and A. Lowe, "The Migration of the Aura, or How to Explore the Original through Its Facsimiles," in *Switching Codes: Thinking Through Digital Technology in the Humanities and the Arts*, ed. T. Bartscherer and R. Coover (Chicago: University of Chicago Press, 2011), 19.

⁸⁸ Benjamin, *The Work of Art in the Age of Mechanical Reproduction*, 14–16.

⁸⁹ Riegl, *Der Moderne Denkmalkultus: Sein Wesen Und Seine Entstehung*, 30–49.

⁹⁰ "ISO/ASTM 52900:2021(En), Additive Manufacturing — General Principles — Fundamentals and Vocabulary," 3.2.7.

⁹¹ Tissen et al., "Using 3D Scanning to Support Conservation Treatments for Paintings." 9.

⁹² The National Gallery - Glossary, "X-Rays," Accessed 1 April 2024, <https://www.nationalgallery.org.uk/paintings/glossary/x-rays>.

APPENDIX I

LIST OF OBJECTS – MARK DION

image	description	collection	year	no.	original size	print size (ca.)
	desired size by Mark Dion desired size fits cabinet desired size doesn't fit cabinet proposed size that fits/max. size possible note					
Cabinet A						depth max. 10 cm
	Leiden PHD coin with image of Minerva goddess of science	MDL	17th century	inv. 3573.1	5,3 x 4,3 x 1,2 cm	35 cm 35 x 28,4 x 7,92 cm
	Cocoa seed pot	MDL to buy	2018		21,5 x 8,5 cm	42 cm 42 x 16,6 cm max. 17% bigger 25,2 x 9,9 cm
	Liber Amicorum Jan van der Does (leather cover)	MDL	1578-1583	inv.3385	16,5 x 11 x 2,9? cm.	36 x 30 cm 36 x 24 x 6,4? cm
	Mortar & Pestle	MDL	1600	inv. 2854 mortar pestle	11,5 x 13,5 x 12,5 cm too big (to enlarge) 22H x 3,3W cm too big to enlarge	36 cm high min. 20% smaller 9,4 x 10,8 x 10 cm 68,9 x 10,3 cm min. 20% smaller 17,6 x 2,6 cm
	Scale (for grain)	MDL	? 17th century	inv.956 bus bascule	22,7 x 11,3 x 10,1 cm too big to enlarge 12,6 x 20,3 x 2,5 cm	70W cm print in actual size (100%)? print in actual size (100%)?
	dog skeleton	Mark Dion			90L x 16W x 65H cm paint original object	38 x 70 cm
	saw fish blade	MDL	end 17th century	inv. 1234.1	97 x 15 x 2 cm	80 cm cm
	rhinoceros horn	Mark Dion			39L x 12,7W x 12D cm paint original object	65 cm

Cabinet B						depth max. 21 cm
	Bust of Descartes	MDL/Mark Dion				60 cm high
	Human heart	Mark Dion			21H x 8,5W x 6,5D cm sizes incl. stand	50 cm high 50 x 20,2 x 15,5 cm
	Amphora	Mark Dion			23,1H x 15W cm	smaller if in cabinet A
	Rapier	MDL	2nd half 17th c.	inv. 4292	105 x 14 x 14 cm	130 cm 130 x 17,4 x 17,4 cm
	Human skull	Mark Dion			18.6L x 13.5W x 18.4H cm paint original object	19 cm
	Large key	Mark Dion			19L x 7,5W x 2D cm paint original object	20 cm
	Apple	Mark Dion			8H x 8W cm	10 x 10 if in cabinet A?
	Plant specimen (Cinemonem Burmanni)	MDL (Hortus)			????	????
	Mummy	RMO?		Ar33?	205 x 66 x 48 cm	70 cm 70 x 22,5 x 16,4 cm
	Horse skull	Mark Dion			56.5L x 22W x 16D cm paint original object	60 cm
	Surgical Knife	MDL	1650	inv. 1206	16 x 2,5 x 1 cm	120 cm 120 x 18,8 x 7,5 cm

Cupboard 3 Cabinet C						depth max. 66
	Forceps	MDL	1650	inv. 1200	21 x 5 cm	20% bigger 24 x 6 cm
	Dental Forceps	MDL	1650	inv. 1220	7 x 13,5 cm	20% bigger 8 x 16,2 cm
	Bodkin Blade	MDL	1650	inv. 1230	14 x 2cm	20% bigger 17 x 2,4 cm
	Cutting device	MDL	1650	inv. 1229	15 x 2,5 cm	20% bigger 18 x 3 cm
	Branding iron	MDL	1650	inv. 1195	38,5 x 6 cm	10% bigger 41 x 6,6 cm
	Knife/Leg saw	MDL	17th or 18th c.	inv. 1219	2,3 x 19, 1cm	20% bigger 2,7 x 23 cm
	Mouth speculum	MDL	1650	inv. 1201	19,5 x 16 x 1,5 cm	20% bigger 23 x 19 x 1,8 cm
	Trephine	MDL	1650	inv. 1214	10,1 x 12 cm	20% bigger 12 x 14,4 cm

APPENDIX II

INTERVIEW MARK DION

LISELORE TISSEN: In my research, I look at how 3D printing affects (technical)art historical research, conservation, presentation, and the work of contemporary artists. To create The Leiden University Phantom Cabinet, you have used 3D-printing and fluorescent paint. To me, this choice is fascinating since 3D printing is a technology that is in line with our contemporary society of mass production, overproduction, and consumerism, which is damaging the ecosystem. Furthermore, creating a 3D print involves toxic resins, inks, and other materials that are anything but environmentally friendly. Since much of your work concerns environmental and ecological issues, I wonder why you used 3D printing?

MARK DION: There are very few options for making something without environmental impact. The display furniture for the work is made of wood, which has its own costs to the environment; it is painted, which is another set of issues. To do a project like this, I must travel to research and develop ideas, which has some impact. At each stage, there are costs, and I don't see 3D printing as extraordinarily more harmful than lighting the room, building and painting the shelving and flying over an ocean.

There are particular properties of the scanning and printing process appropriate to this endeavor. One is that you can print the objects to any scale. Something as large as a mammoth skeleton can be printed the same size as a human skull. Also, something quite small can be equally enlarged. This process was ideal since I wanted to give each object the same material weight. I have used this playful relation with scale for all the projects with which I have used 3D printing. The original objects themselves come from the national collections. These are not objects which are loaned out or could be altered, they are important specimens or art objects. While I could never borrow them for such an exhibition, I could have scanned them in Situ and reproduced them. I often work with museum collections, and the objects return to their storage areas at the end of the project. This means the works have a very short life of a few months. Through the technology of 3D printing, I can lend the objects, copy and print them, and then I have the sculptures for as long as possible. The life of a work is extended. Indeed, the piece made for

Leiden, The Natural Sciences, is now in a permanent public collection in Denmark.

Did you select the objects yourself? What made you choose certain objects?

Yes, of course, I selected the objects. Each object or group represents a branch of scientific knowledge represented in the university collection and the museum. I tried to find the best embodiment of each discipline without being too obvious.

In terms of design, was likeness to the original objects something to consider? If so, when did you decide the likeness was sufficient?

It was important for me to have the printed objects as close to the original object as possible. However, the sculptures are then covered with a thick coat of phosphorescent paint, which does mask some detail. The sculptures become more generalized, more indexical. I was pleased with what the 3D printing technique could deliver. In your book, you oftentimes mention the importance of education, engagement, and the involvement of the viewer/public in the creation of the significance of art. How did you translate this value into The Leiden University Phantom Cabinet? Did you offer a multisensory experience, for instance? As I have many books, I am not sure which exact text you are referring to.

This work does, I think, engage the viewer in interesting ways. Particularly since it is such a hidden treasure room. Because of the stairs, the awkwardness of the space, and the difficulty of seeing the work, it forces the viewer to physically engage, deepening their connection. However, I have also heard from people who have seen the work that they feel I was shoehorned into a terrible corner space and not given a respectable site to work in. I do like the idea that the piece has to be discovered.

You often critique the contemporary museum in your artworks and writings since they take away the context of the work of art. I agree that this isolation of objects increases the distance between the visitor and the artwork and "kills"

the artwork since it prevents interaction, engagement, and excitement. Yet, simultaneously, you mention the educational value of objects and how they can remind us of how the world is changing. Paradoxically, there should be an urge to conserve them for that purpose. Did you consider this dilemma when you created the Leiden University Phantom Cabinet?

What are collections for, what is their purpose, and why do we keep them? These are questions I am always interested in interrogating. As a believer in the importance of things, I identify with the museum's collection and preservation mandate while also recognizing that while an object may not significantly change over time, how we use the object, and which stories we tell may dramatically shift. We are witnessing this reassignment of meaning in museums today as they use the lens of post-colonial critique to consider the collections. The reference to phantoms is an acknowledgment of this notion. Museum objects are mere ghost, they do not live in the sense that the objects once had a practical function. In this sense the museum object is a zombie, a living dead thing.

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How do you ensure the continuity of your artworks even if their materials reveal a temporality?

This is a good question about technology. Since 3D printing is a new technology, it will always be tethered to our moment. Yet since, unlike various visualization technologies like video, film, and computer-generated images, the result of 3D printing, as I have worked with here, is to reproduce something in space, which is a copy with great fidelity. So, it should not signify "of our moment" as much as it signifies the original. So, I feel that 3D printing has the potential to escape some of the pitfalls of other technologies in the sense of feeling dated.

Certainly, for me, the first thing a viewer thinks should not be that these objects are 3D printed. That detail should not be in the forefront of the viewer's experience. Of course, we don't really know the longevity of the 3D-printed objects. Since the files exist, they could I imagine be reproduced

should the originals fail. However, they are clearly not bronze. The sculptures will certainly out live me.

Since The Leiden University Phantom Cabinet is made with 3D printing, this signifies that there is a 3D model out there with which you can 3D-print infinite versions of your artwork. In terms of ownership, who ultimately owns The Leiden University Phantom Cabinet?

The work is not the individual objects. The artwork is the installation in the setting, with the elements together in their particular relationship. The work cannot exist if moved from its space in the museum. So, the museum owns the work as long as they maintain it in Situ. If they move or alter the situation, they no longer have a work of mine.

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In your texts, I noticed that you have a strong opinion or resentment toward museums' authority and power in particular. Regarding The Leiden University Phantom Cabinet, have you considered publishing your 3D models on an open forum such as SketchFab so people can use them to create their works of art?

As I have said, the work is not the objects. The individual printed objects are not the artwork.

In a conversation with Julie Courtney, you say that objects "speak" and expand that speech in context with other objects. Could you explain this a little bit more? What does an object on its own say compared to being placed in a group? How did this translate to the objects of The Leiden University Phantom Cabinet?

Objects are a language, adjust the syntax and you change the meaning. Place two objects together, and you have a dialog; place them on a table, and you have an essay.

I suppose you have noticed the increasing use of scientific methods (e.g., Macro fluorescence scanning (MA-XRF), infrared reflectometry (IRR)) to prove the truthfulness of the materials of an artwork, object, or specimen. Besides

being relevant for the authentication of art, this has also led to the growing field of technical art history that focuses on object-based research, combining traditional art historical inquiry with insights from science and technology. The aim is to understand the object's trajectory from an artistic idea to the object's present state holistically. I wonder what you think of this development?

Investigation into material science and discovery in the plastics arts is a fascinating field. I am a big fan of *The Making and Knowing Project* by Pamela Smith at Columbia University. This program looks at invention as the intersection of alchemy, Proto-science, and craft and skill practices in the Early Modern period. I have spent some time with Pamela discussing this and how the workshop's hands-on approach is so illuminating for the scholars.

I am a pretty conceptually driven artist. The idea comes first and then there is the issue of how to best manifest it into physicality. There are so many factors that relate to how that is done, including time, skill, budget, new materials, access to assistance, and technology. Of course, all of these factors affect the outcome of the work, but they are tricky for a historian to understand fully.

Based on these scientific methods, it becomes possible to reconstruct, or at least guess, what artworks must have looked like. In one of my research projects, I used 3D printing to reconstruct what The Crucifixion – a medieval panel – must have looked like with its originally golden background, which was covered by a layer of blue azurite a century later. In an interview with Michelle Grabner, you say that technology makes the invisible visible which can augment our interest in the real world, yet at the same time, signifies that the same values we have toward entertainment are transferred onto the natural world.

Do you think how a 3D print can be manipulated to display the artwork in different or even multiple ways can help provide a more diverse story about one artwork? Or do you believe it will lead to a wrong way of viewing the world? I thought Tales from the Dark Side was very striking because it plays with the commodification of art and the elements of authenticity. Furthermore,

in this artwork and other texts, you also refer to the cycle of the restorer who freezes the artwork and determines its unique significance - albeit true or false— which is guided by the monetary value of art. Do you think making identical copies can release the artwork and the restorer from this economical hold and the artwork's historicity?

There are many ways to value things, but it does seem like economic value, monetary worth, trumps other values far too often. I think your question is one about aura value maybe. It is a complex notion, emanating something unique from an artwork which has to do with its direct contact with the hand of its maker. It is that special status of an artwork, it's proximity to the maker, which for many imbues a work with an almost holy ambience.

Needless to say, I am not under the beguilement of such an argument, but for those who are, I am not sure that exact physical copies will break the spell. I do think 3D printing is an interesting technology to challenge the power of the aura of the original. That is undeniably one of the attractions of the technology for me.

Also, I liked how it demonstrated how a reproduction's " performance " can change. Due to its reframing (literally and figuratively speaking), a reproduction can become the original. Does a division between an original and a 3D reproduction make sense to you? Do you think a newly 3D-printed version is as valuable as its original counterpart? Which elements determine your answer?

It seems difficult to escape from the concept of the original in the hand of the maker or user. This is an idea that manifests power. The notion that a sickle, was actually in the hand of a peasant farmer, and the object retains the patina of use, the shape and texture of its application is powerful. We could certainly recreate the look, tone, and feel of the object, but it would be artifice.

Keeping the authenticity debate of art in mind, do you think creating a 1-1 3D printed reproduction of an existing masterpiece by Vermeer or Rembrandt differs from the reproductions you created?

In my work, I am keen to foreground the artificial nature of the reproduced objects. I give them color, change their scale, precisely to draw attention to the notion that these are not the originals. So my goals are very different from the faithful reproduction of a painting, which has the status of being a copy functionally indistinguishable from the original.

In Deep Time/Disney Time, you say that the past is a version of the present and the future is more of the same since we prefer to exclude negative and difficult aspects of life (e.g., depression, racism, etc.) and instead believe in an idealized version of the world or fantasy. Do you think this strong belief in a “Disneyfied” version of the world has become even more prominent, given the growing popularity of art in the mainstream thanks to new technologies such as 3D printing, AI, VR, and AR?

Certainly, there is a temptation for many of these new technologies to produce a lived experience that is more utopian and idealized. That is why it is so ironic that instead, they embrace so full-heartedly the opposite in a dystopian world of conflict, destruction, and competition. There are so few examples of these technologies employed to make comforting and affirmative spaces rather than spaces of strife. I guess at this point, they are mimicking the entertainment industry, which thrives on confrontation and Thanatos.

As you said, conventions are never stable but are always in motion. In one of my projects, I tried to use a 3D print of a Mixtec skull that was looted from Oaxaca and brought to the Netherlands to negotiate issues of restitution in a co-creative way. I hope to provide a way to talk about these issues in a way that is not culturally and time-dependent. Do you think museums can use technology such as 3D printing to overcome these fluctuations in perception and redefine their role in society?

Like so many technologies, there is great potential for progressive and productive uses of 3D printing, but there must be the will to use them in such a way. Your example of the looted skull is full of potential. If the museum can materialize such exacting copies of objects, stolen from around the world,

does this free them up to return the objects to cultures they were taken from? Again, we are often brought back to the power and value of the aura of the original.

Going to museums now, what do you think it shows us about the world and where we are heading?

My attitudes toward museums are complex and ambivalent. On one hand, I identify with the mission of the museum to produce knowledge through a direct contact with things. This is something I have directly experienced, from a young age and I know personally the positivity of museums as transformational spaces.

On the other hand, museums are sites of ideology, often controlled, at least financially, by the state or the wealthy, who use the museum to promote a very particular worldview. The history of museums as tools of nationalism and sites for the promotion of particular social values is well known.

What makes me confident of the museum's importance today is to actually spend time behind the scenes, meeting the staff who shape the content. They are, more often than not, critical people, highly educated historians and professionals willing to foster difficult discussions and examine complex issues. From the outside, the museum may seem like an ideological juggernaut, unified in its positions, but from behind the doors, it is a war of ideas, a place of debate, criticality, and discourse. I take great comfort in the fact museums are sometimes in the hands of rigorous scholars who are open to change and dedicated to making the spaces more open, progressive, and responsible.

