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Sculpting Digital Realities

Notes on Truth to Materials, the Aesthetic Limit, Site-Specificity and 3D-Printing

Abstract

Today, hybrid forms of reality coexist and overlap in techniques like augmented or mixed reality and open new avenues of perception. The gaze of the user is absorbed; the whole body is involved in an immersive corporeal (multisensory) experience. The expanded field of sculpture has also been impacted by digital technologies since the 1960s, such as CNC technology, VR, or 3D scans and prints, although an art history of digital sculpture is still developing. My paper aims to discuss what terminology in art history corresponds to these works, given their postmedium condition and infrastructural accessibility, their various materialities, immateriality or rather neomateriality (Christiane Paul), their aesthetic limit (Ernst Michalski), and interactive features, including real-time processes. Following the paradigm of *the sculptural in the expanded field* and by using artistic examples, among others Herbert W. Franke, Jeffrey Shaw, Banz & Bowinkel, and Morehshin Allahyari, I like to ask how media-specific parameters, such as truth to materials, scalability, and site-specificity, are altered when sculptures circulate as files online and can be printed in different sizes. What ontological status do such computer-aided works possess that can be experienced physically and virtually?

Key Words

Digital Realities, Virtual Sculptures, Truth to Materials, Plasticity, Aesthetic Limit, Site-Specificity, Siteness, Neomateriality, 3D-printing, Morehshin Allahyari, Banz & Bowinkel, Herbert W. Franke, Daniel Rourke, Jeffrey Shaw

Introduction

Today, hybrid forms of reality-construction coexist and overlap in techniques like augmented or mixed reality. They therefore open new ways of perception: the gaze of the viewer/user is absorbed; the whole body is involved in an immersive, corporeal, often multisensory experience.[1]

Though an art history of digital sculpture and the sculptural in the (post-)digital age is still developing, the expanded field of sculpture has been impacted by digital technologies since as far back as the 1960s. CNC technology (computer numerical control, e.g., automated control of machining tools, such as mills), 3D scans and prints, or Augmented/Virtual Reality have all made their mark on sculptural practice. So, we still have to ask what kind of art-historical terminology is suitable to these works, especially given their postmedium condition, accessibility, materiality, immateriality or neomateriality, aesthetic limit, interactive features, scalability, real-time processes, and nonlinearity. My paper aims to discuss how established sculptural concepts, such as "truth to materials" or "neomateriality" (Christiane Paul), plasticity and the ä*sthetische Grenze* (aesthetic limit; Ernst Michalski), multiperspectivity, and "siteness" configure our understanding of *the sculptural* in a postmedium condition.

Transforming traditional sculpture aesthetics, digital and virtual objects are characterized mainly by a visual presence—for example, simulations on the surface of a screen based on algorithms. Without sharing the same spatial conditions as its counterpart, however, they are characterized by a specific haptic, including different interfaces such as touch screens, controllers, or keyboards. The expansion into virtual space as well as the emergence of digital sculptures, which is already indicated in Jack Burnham's survey work *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (1968), became since then an essential form of *the sculptural* in the expanded field. Burnham is especially interested in artistic works whose individual components interact with each other and with their environment, works that are self-organizing, data-generating, and information-processing in real time.[2]

What potentials do these tool-based technologies, such as computer-generated, interactive Virtual Reality, Augmented Reality, or 3D-printing of a layered construction of material

1 Part of the following text is based on my habilitation *Erweiterung des Skulpturalen: Analysen und Theorien aktueller Grenzphänomene: "Non-human Living Sculptures" seit den 1960er Jahren. Hans Haacke und Pierre Huyghe* (2020), which is forthcoming. Sincere thanks are due at this point to Verena Kuni and Mara-Johanna Kölmel for their critical reading of my text and their valuable comments.

2 This kind of "bridge between the external plastic infinite and the internal plastic infinite," which "the objects never come to an end in themselves but intersect with infinite combinations," was already pronounced by Umberto Boccioni in his *Manifesto of Futurist Sculpture* (1912)—only partially realizing it in his own artworks during his short career. Umberto Boccioni, "Technisches Manifest der futuristischen Plastik" (1912), in *Umberto Boccioni: Futuristische Malerei und Plastik*, ed. Astrit Schmidt-Burkhardt (Dresden: Verlag der Kunst, 2002), pp. 237–49, here pp. 248–49.

accumulation, hold for current concepts of sculpturality?[3] Burnham assigned postformalist sculpture the status of a so-called *real-time system* in view of its experimental openness, kinetic characteristics, mechanization, and "form of biological activity":[4] "The machine, then, becomes the legitimate heir to the sculptural tradition of form creation."[5] Around ten years later, in her 1979 essay "Sculpture in the Expanded Field," Rosalind Krauss developed a *structural* understanding of sculpture beyond material-specific questions, thereby opening a postmodernist inquiry into the defining traits of *the sculptural* in a postmedium condition.[6] Following the paradigm of "Sculpture in the Expanded Field," and by using artistic examples, among others Herbert W. Franke, Jeffrey Shaw, Banz & Bowinkel, and Morehshin Allahyari, I would like to ask further how media-specific parameters, such as scalability and site-specificity, are altered when sculptures circulate as files online ubiquitously and can be printed in different sizes. Which forms of participation does the respective interface address? What ontological status do such computer-aided works possess that can be experienced both physically and virtually? Referring to the historical, established terminology of sculpture theory, my text aims to discuss which terms and concepts are still viable for these sculptural phenomena in the digital and virtual realm.

Herbert W. Franke and Jeffrey Shaw's Concept of *Virtual Sculptures* in the context of *Truth to Materials* and *Neomateriality*

In the 1960s, the scientist, science-fiction author, and artist Herbert W. Franke began working with computers and oscilloscopes and later also sought to expand the boundaries of sculpture toward virtual space. The absence of statuary and gravitation, the change of contour, an all-pervasiveness shaped by self-motion, and a time-based plasticity describe his "virtual sculptures," as Franke calls them. In contrast to "truth to materials," he insists on "objects" previously considered "impossible" to produce, including the ignorance of gravity, mechanical instability, and permeations: "Could the computer lead us also in new areas of sculptures? A way to find an answer is to ignore the mentioned conditions for physical realization and try to design not realizable 3D-forms."[7] By using computers, it became possible to simulate materiality and to create mobile, partly interactive digital sculptures using an enlarged repertoire of forms with an elastic scalability.

3 In German there is the terminological distinction of *Skulptur/skulptural* and *Plastik/plastisch*. While historically the two terms denote two modes of production, since with *Plastik* (Greek *platto* = to form) material is accumulated, while *Skulptur* (Latin *sculpere* = to cut, engrave, carve) requires a subtractive process, today *Skulptur* is often used synonymously. Due to its material accumulation, 3D-printing refers to *Plastik*.

4 Jack Burnham, *Beyond Modern Sculpture: The Effects of Science and Technology on the Sculpture of This Century* (New York: Braziller, 1968), p. 6.

5 Ibid., 314.

6 See Martina Dobbe and Ursula Ströbele, eds., *Gegenstand: Skulptur* (Paderborn: Wilhelm Fink, 2020), pp. 1–16.

7 See Herbert Franke's website, http://www.herbert-w-franke.de/VirtS1.html (accessed January 5, 2022).

Departing from an idealistic aesthetic and the primacy of the *idea*, with its sublimation or negation of materials, the "truth to materials" paradigm has moved from the Arts and Crafts to the fine arts since the nineteenth century; material has been assigned style-forming qualities.[8] According to Günter Bandmann, material is iconologically expressive and can be a carrier of information in itself. He refers to the etymological proximity between "justice/truth" and "appropriateness": "The material contributes something to the meaning of the image due to its specific natural or also attributed qualities, but sometimes only by differentiation from the neighboring material."[9] Changes in perspective occurred through John Ruskin, the Arts & Craft movement, and Gottfried Semper's materialist-positivist considerations. History is stored in the materials themselves, following Ruskin, who advocated traditional material processing and rejected imitation with substitute materials that became popular during the era of industrialization.[10] Werner Hofmann emphasizes that the demand for "truth to materials" in sculpture emerged during that time, when craft knowledge had become "lost in superficial virtuosity."[11] Henry Moore is a frequently quoted sculptor in this context: "*Truth to Material.* Every material has its own individual qualities …. Stone … should keep its hard tense stoniness."[12] Burnham himself is skeptical of "truth to material" and underlines its ambiguous premise: "Any forming or shaping must take advantage of the plasticity of each material, and, more importantly, no material will do what it is not meant to do."[13]

8 Günter Bandmann, "Bemerkungen zu einer Ikonologie des Materials," *Städel-Jahrbuch*, N.F. 2 (Frankfurt, 1969), pp. 75–100, here p. 77. See also Günter Bandmann, "Der Wandel der Materialbewertung in der Kunsttheorie des 19. Jahrhunderts," in *Beiträge zur Theorie der Künste im 19. Jahrhundert*, vol. 1, ed. Helmut Koopmann and J. Adolf Schmoll, gen. Eisenwert (Frankfurt am Main: Klostermann, 1971), pp. 129–57. See also Thomas Raff, *Die Sprache der Materialien: Anleitung zu einer Ikonologie der Werkstoffe* (Berlin & München: Deutscher Kunstverlag, 1994), pp. 18–32; Dietmar Rübel and Monika Wagner, and Vera Wolff, eds., *Materialästhetik: Quellentexte zu Kunst, Design und Architektur* (Berlin: Reimer, 2005).
Already in 1849 Gottfried Semper proclaimed truth to materials: "The material speaks for itself and appears, undisguised, and in the form, in the relationships, which are … tested. Wood [appears] as wood, iron as iron, each according to its own laws." See Monika Wagner, "Materialtäuschungen," in *Lust der Täuschung: Von antiker Kunst bis zur Virtual Reality*, ed. Andreas Beitin and Roger Diederen (Munich: Hirmer, 2018), pp. 127–68, here p. 131, translation by the author.

9 Bandmann, "Bemerkungen zu einer Ikonologie des Materials," 1969, p. 77, translation by the author.

10 Ibid. See also Nadine Rottau, *Materialgerechtigkeit: Ästhetik im 19. Jahrhundert* (Aachen: Shaker, 2012). In *Der Stil* (1860), for example, Semper praised the "absolute docility of the material" ("die absolute Gefügigkeit") of Kautschuk. Gottfried Semper, *Der Stil* (Frankfurt: Verlag für Kunst und Wissenschaft, 1860), p. 15.

11 Werner Hofmann, *Die Plastik des 20. Jahrhunderts* (Frankfurt am Main: Fischer, 1958), p. 21.

12 Burnham here quotes Moore after Herbert Read. Burnham, *Beyond Modern Sculpture*, 1968, pp. 95–96. Material in its function as information carrier and at the same time as medium, which has lost its neutrality since Niklas Luhmann's sociological system theory and his understanding of communication as a triad of information-communication-understanding, is also a profitable theory for the analysis of sculptural situations and system-aesthetic concepts. See Niklas Luhmann, *Soziale Systeme Grundriß einer allgemeinen Theorie* (Frankfurt am Main: Suhrkamp, 1984); Niklas Luhmann, *Die Kunst der Gesellschaft* (Frankfurt am Main: Suhrkamp, 1995). Henry Moore and Herbert Read use "material" in singular.

13 Burnham, *Beyond Modern Sculpture*,1968, p. 96.

Moore is concerned with hardness, compliance, elongation, and surface textures. In nature, he asserts, there is a diversity of forms and rhythms, enhanced by inventions such as the microscope and telescope (this is important to Burnham). He therefore seeks to evoke the richness of these forms. Burnham understands Moore's adherence to "truth to materials" as a reaction to the falsity of Neoclassical and Romantic carving, only setting up an antidote for the use of materials. The attraction to "truth to materials stems, according to Burnham, from its ring of moral equilibrium and natural propriety.[14] Referring back to the nineteenth century, Burnham considers this sculptural paradigm as an "overreaction to earlier excesses"[15]—even though this question is still crucial, especially for computer-based works. Krauss describes this relationship between artist and material as "alert responsiveness" and underlines that the idea cannot be separated from the artist.[16] Indeed, how can one evoke the haptic experience of the textures and surfaces of digital objects, such as Franke's, that are perceived visually and might be printed in different materials?

This embeddedness of the digital in the objects, images, and structures we encounter on a daily basis and the way we understand ourselves in relation to them seems to be an essential characteristic of the sculptural approaches that are here discussed. Christiane Paul's concept of "neomateriality" elucidates this expanded vision of materiality: neomateriality, according to Paul, "describe[s] an objecthood that incorporates networked digital technologies, and embeds, processes, and reflects back the data of humans and the environment."[17] Neomateriality reveals its own coded materiality and describes a twofold operation: first, the convergence of digital technologies in various materialities and second, how this fusion has changed our relationship with these materialities, especially sculptures. Verena Kuni's term "analogital" might be also understood as fruitful approach to describe these entanglements and "the transformations of analog and digital material(itie)s and media," exploring our culture's fluidity and nomadic character.[18]

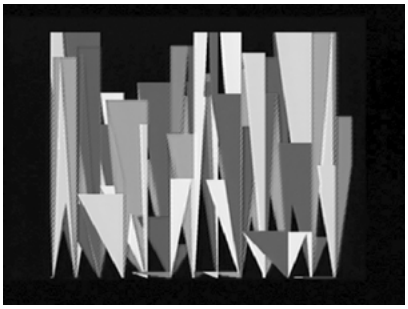
14 Ibid.

15 Ibid., p. 155. Monika Wagner traces the term back to Goethe's plea (1778) for the tortured stones of Milan Cathedral and his demand for empathy with the material itself. Monika Wagner, "'Materialgerechtigkeit': Debatten um Werkstoffe in der Architektur des 19. und frühen 20. Jahrhunderts," *Historische Architekturoberflächen: Kalk – Putz – Farbe/Historical Architectural Surfaces: Lime—Plaster — Colour*, ed. Jürgen Pursche (ICOMOS, Hefte des Deutschen Nationalkomitees XXXIX), no. 39 (2003), pp. 135–38, here p. 135. See also Monika Wagner, "Vom Ende der materialgerechten Form: Kunst im Plastikzeitalter," in *Stoffe: Zur Geschichte der Materialität in Künsten und Wissenschaften*, ed. Barbara Naumann, Thomas Strässle, and Caroline Torra-Mattenklott (Zurich: vdf Hochschulverlag AG an der ETH, 2006), pp. 229–46. Wagner, "Lemma zu Material," in *Ästhetische Grundbegriffe*, ed. Karl-Heinz Barck et al., vol. 3 (Stuttgart/Weimar: Metzler, 2001), pp. 866–82. Wagner does not discuss Moore and sculpture here. See also Wolfgang Kemp, "Material der bildenden Kunst. Zu einem ungelösten Problem in der Kunstwissenschaft," *GhK Gesamthochschule Kassel Prisma* 9 (December 1975): 25–34.

16 Rosalind Krauss, *Passages in Modern Sculpture* (Cambridge, MA: MIT Press, 1981), pp. 143–44. She mentions the same quote by Henry Moore.

17 Christiane Paul, "From Immateriality to Neomateriality: Art and the Conditions of Digital Materiality," in *Proceedings of the 21st International Symposium on Electronic* Art (2015), pp. 552–55, https://www.isea-archives.org/docs/2015/proceedings/ISEA2015_proceedings.pdf (accessed January 5, 2022).

18 See Verena Kuni about the analogital condition(s) of the sculptural in this volume.



1 Herbert W. Franke, ORCHID, 1984–1992, computer-based animation, screenshot, collection of the ZKM.

Franke's first works were written in QUICK BASIC and were presented on a monitor or on a television screen, an object whose sculpturality he considers part of the work.[19] *ORCHID* (fig. 1), for example, is interactive and connects his early computer graphics with more performative, participatory works: triangular color patches begin to form and overlap with each other from the bottom edge of the screen. With the keyboard, the user can shift the graphics *en bloc* to the top or bottom.

Significant, at least for Franke, are the detailed descriptions in catalogs and interviews of the technical approach in his early works, sometimes supplemented by functional drawings of the respective apparatus—for example in *Computerkunst, Computergrafik* (1971) and *Apparative Kunst. Vom Kaleidoskop zum Computer* (1973).[20] These publications document the still young art form of computer-based art, which pleaded for legitimacy and recognition and attempted to counteract the then unknown "mystery" of the computer. Many contemporaries doubted the artistic value of the exhibits because many of the protagonists belonged to the scientific-technical field. Similarly, today the processes of AI-based art are often perceived as a black box.[21]

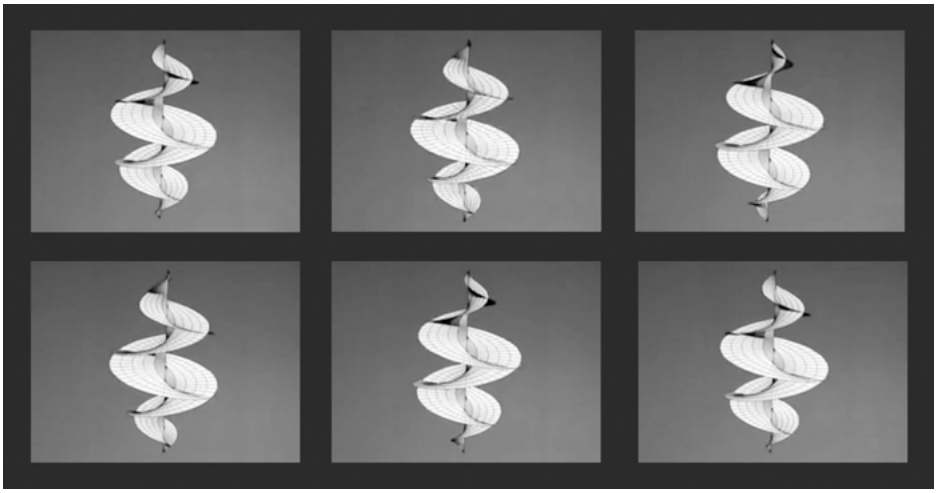
Franke writes: "Because the virtual reality will become increasing meaning in the art of tomorrow, the question of construction with material will become negligible."[22] He here raises the question of whether a "materially appropriate" digital sculpture even exists. His

19 Before early computers were available, Herbert W. Franke made experimental and generative photographs in the 1950s, which were followed by a series of oscillograms produced with the analogue technique of a cathode ray oscillograph. During 1971–73 and 1979–85, Franke curated the exhibition *Ways to Computer Art*, which was then exhibited in different Goethe Institutes worldwide.

20 Herbert W. Franke, *Computergraphik, Computerkunst* (Munich: Bruckmann, 1971). Herbert W. Franke and Gottfried Jäger, *Apparative Kunst: Vom Kaleidoskop zum Computer* (Cologne: Verlag M. DuMont Schauberg, 1973).

21 See Mercedes Bunz, "The Calculation of Meaning: On the Misunderstanding of New Artificial Intelligence as Culture," *Culture, Theory and Critique* 60, nos. 3–4, Culture & Technics: The Politics of Simondon's Du Mode (2019): 264–78, doi: https://www.tandfonline.com/doi/abs/10.1080/14735784.2019.1667255 (accessed May 3, 2022).

22 Herbert W. Franke, "Virtual Sculptures," in *Mathematics and Culture II*, ed. M. Emmer (Berlin/Heidelberg: Springer, 2005), pp. 145–49, here p. 149.



2 Herbert W. Franke, *Spindle*, 1993, loop.

geometric, sculptural formations are recognizably afflicted with the historicity of design and evidently differ from today's aesthetics of the digital: *Spindle* (1993) (fig. 2) is a helical, twisted, counter-rotating object, a sculptural mobile, which in its plasticity might be barely translated into established materials. Shown in rotation, it evokes an upward or downward screwing movement. *Donut* (1995) demonstrates his interest in unusual movements of pulsation and torsion. According to Franke, the virtual sculpture should still remain a uniform object with a concrete three-dimensional form, even if he underlines the inspiring challenge of "never seen objects and movements."[23] Despite of his mathematical-artistic interest in technological innovations, he still remains linked to the haptic translatability of sculpture and its object-based aesthetics. But one could also ask if here, in early digital sculpture on screens, addressing the sense of sight, a reversal of the sensory hierarchy manifests itself. After all, such artists explicitly refer to the concept of sculpture, but at the same time no longer create haptic sculptures. Since 2005, Franke has been using his own virtual *Z-Galaxy*, through which the user can walk with an avatar—a first kind of embodied interface—and take a closer look at the exhibits. Named after computer pioneer Konrad Zuse, the world is a virtual art exhibition.

The sculptural possibilities in the age of the digital are also discussed by Simon Penny in his critical reading of Burnham (1999): "The problematic discontinuity between the tangibility of sculpture and sculptural practice and the ephemeral temporality of informatics

23 Franke, "Virtual Sculptures," 2005, p. 149. "But … it [virtual sculpture] should—after all the transformations and movements—remain a uniform object, for instance based on the conception of cyclic processes or on random controlled deviations from the prototype. ... In the large field of computer art the virtual sculpture will be only a little facette, but here can [sic] originate fascinating results."

is a case study in the cultural phase-transition of our times."[24] Among the main new characteristics of the medium sculpture are disembodiment, deterritorialization, and the code as ephemeral structuring system, "a long step from the pragmatic materiality of sculpture." Penny concludes that despite these new "numerous explorations into virtual sculpture," no new aesthetics of the digital has yet emerged.[25]

The paradox of a virtual reality has been appropriated by the increasing digitalization since the 1990s, leading to a growing "media-induced softening of our understanding of reality," as Wolfgang Welsch proclaims.[26] Jean Baudrillard, for his part, equates virtuality and virtual reality.[27] He criticizes virtuality for aiming only at the erasure of the real through its double. The real and the virtual become indistinguishable on an ontological level. Etymologically, virtuality is borrowed from the Latin *virtus* (virtue, valor, efficacy). The French word *virtuel* means "capable of acting," "existing as a possibility according to its disposition."[28] Virtuality is consequently an entity that, though not physical, is present in its functionality or effect.[29] As Eva Wilson has precisely outlined, beyond this dualistic concept of reality and virtuality, virtuality opens up a field as an aesthetic, perception-theoretical category, departing from technical developments of the early optical physics, such as stereoscope, kaleidoscope, and photography.[30] Considering Thomas Aquinas and Henri Bergson, virtuality stands in relation to reality in temporal latency and recursive, iterative, and reflexive difference.[31] According to Bergson, the (continuously) updated-recognized image is the virtual image. Temporal dimensions of past experiences are thus included in the virtual image.[32] Following Thomas Aquinas, who equates *virtualiter* and *dynamis* as "possibility" in an Aristotelian sense, the history of the virtual leads from a possible force striving for actualization to an element temporally antecedent to reality. While the possible arises temporally after the real,

24 Simon Penny, "System Aesthetics and Cyborg Art: The Legacy of Jack Burnham," *Sculpture Magazine* 18, no. 1 (January/February 1999), https://sculpturemagazine.art/systems-aesthetics-cyborg-art-the-legacy-of-jack-burnham/ (accessed January 6, 2022). "Not only has CAD revolutionized drawing and modeling, but the utilization of computer-controlled milling, stereolithography, and so forth has changed the actual creation of conventional sculpture. More importantly, microprocessors have transformed the language of spatial art practice into a temporal and interactive practice. See also: Christian Wolf, "Skulptur Virtuell: Augmentierte und Virtuelle Realität in der Plastik," in *Skulptur Pur*, ed. Ulrike Lorenz, exh. cat. Kunsthalle Mannheim (Heidelberg: Kehrer, 2014), pp. 114–24.

25 Penny, "Systems Aesthetics and Cyborg Art," 1999.

26 Wolfgang Welsch, "Virtual Anyway?" in *Media and Social Perception*, ed. Candido Mendes and Enrique Larreta (Rio de Janeiro: UNESCO, 1999), pp. 242–85. Translation by the author.

27 Jean Baudrillard, *Die Illusion und die Virtualität* (Wabern-Bern: Benteli, 1994).

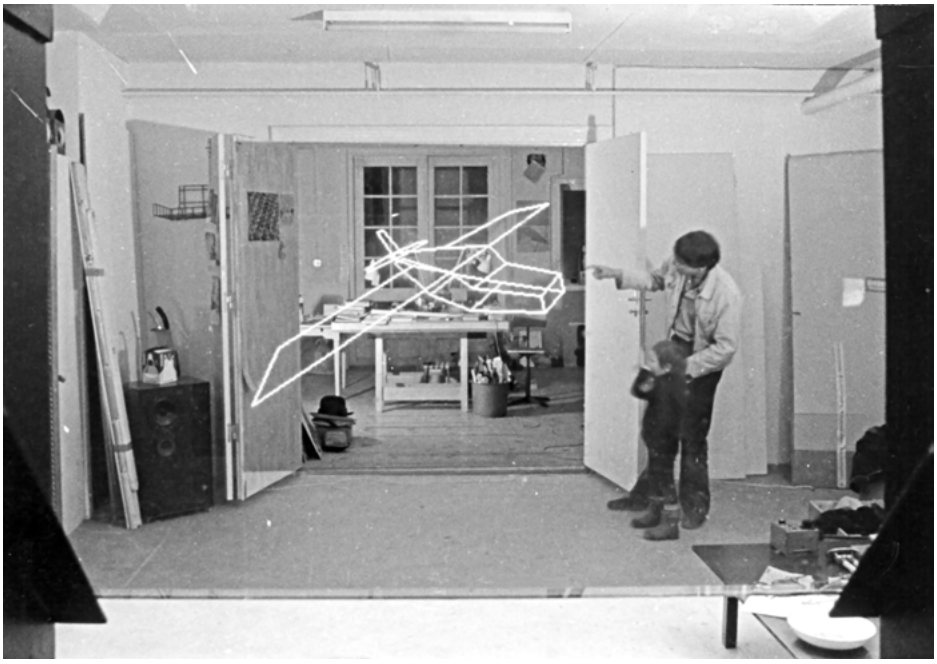
28 See *Historisches Wörterbuch der Philosophie*, vol. 11, ed. Joachim Ritter et al. (Basel: Schwabe, 2001), pp. 1062–67.

29 See Lambert Wiesing, "Virtualität und Widerstreit," in *Skulptur – zwischen Realität und Virtualität*, ed. Gundolf Winter, Jens Schröter, and Christian Spies (Munich: Wilhelm Fink, 2006), pp. 179–90.

30 Eva Wilson, "Hinter den Spiegeln: Virtualität, Rekursion und virtuelle Bilder im 19. Jahrhundert," in *Periphere Visionen: Wissen an den Rändern von Fotografie und Film*, ed. Heide Barrenechea, Marcel Finke, and Moritz Schumm (Paderborn: Wilhelm Fink, 2016), pp. 97–112, here p. 97.

31 Ibid.

32 Ibid.



3 Jeffrey Shaw, Theo Botschuijver, *Virtual Sculpture*, 1981, ZKM | Center for Art and Media Karlsruhe, ZKM-01-0162-02-03081.

the virtual exists temporally before the real.[33] Thus the virtuality of a form exceeds its actuality, or as Brian Massumi puts it: "In a word, experience is our virtual reality."[34] The virtual indicates the multitude of possible states that any entity may experience. One example of a virtual image is the reflection in a mirror, as the artist Jeffrey Shaw demonstrates. Virtual realities, as Sibylle Krämer has summarized, are a technique to enable interactive reflections of symbolic worlds, including the proprioceptive perception."[35]

In the field of art, this includes the question of the relationship between facticity, which refers to the actually given, and factuality, which refers to the actualization of the factual during the reception process and on the production-aesthetic side. Facticity is considered as one of the main media-specific criteria of sculpture, insisting on materiality, spatiality, and plasticity. While facticity refers to the hand- or machine-made, including its presence of

33 See, for example, Clara Völker, *Mobile Medien: Zur Genealogie des Mobilfunks und zur Ideengeschichte von Virtualität* (Bielefeld: transcript, 2010).

34 Brian Massumi, "Sensing the Virtual, Building the Insensible," in *Hypersurface Architecture,* ed. Stephen Perrella, *Architectural Design,* profile no. 133, vol. 68, nos. 5/6 (May–June 1998), pp. 16–24.

35 Sybille Krämer, "Zentralperspektive, Kalkül, Virtuelle Realität: Sieben Thesen über die Weltbildimplikationen symbolischer Formen," in Gianni Vattimo and Wolfgang Welsch, *Medien-Welten Wirklichkeiten* (Munich: Wilhelm Fink, 1998), pp. 27–37, here p. 32.

being, factuality expresses itself as time-based actuality, for example in the temporality of perception. Factuality, therefore, occurs in the reception process itself.

In 1981, Jeffrey Shaw realized his *Virtual Sculpture* (fig. 3) without any computer-aided accessories. Using a Fresnel lens and a semitransparent mirror, a stereometric image created the impression of virtually floating figures that move when the monitor is rotated. The figures can only be visually perceived through contour lines. Although the discrepancy between, for example, a Corten steel sculpture by Richard Serra and Shaw's floating objects could barely be greater, it is precisely this gap that demonstrates a provocative adaptation and questions conventional concepts of sculpture. The virtual and also digital sculpture is dependent from the position, the movement, and the perspective of the viewers, and thus it is closely intertwined with them. It is time-based and exists in a systematic aesthetic relationship with both its apparatus and the recipient. Whereas the digital concerns the medium itself, the virtual here primarily describes the relationship between the work and the viewers; the virtual *can* also be digital. Already in 1919–20, Naum Gabo described his *Kinetic Construction (Standing Wave)* as leaving the impression of a *virtual volume*, based on motion and optical effects. In relation to its etymological background, a virtual sculpture could be also imaginary, seen by the inner eye of a person.

Plasticity and the Aesthetic Limit (*ästhetische Grenze*) in VR-Sculpture

Recent examples of contemporary artists such as Mélodie Mousset (*HanaHana 花華*, 2017), Jon Rafman (*Sculpture Garden*, 2016), Banz & Bowinkel (*Mercury*, 2016), and Jeff Koons (*Lady Bug*, 2014; *Phryne*, 2017) demonstrate the artistic concepts to which technological developments can lead today.[36] AR elements are integrated into space-spanning works, as in Pierre Huyghe's *After ALife Ahead* (2017), where a moving, sculptural collage of black trapezoids appears on a stadium ceiling with the help of an app.[37] Today, one could ask whether new sculptural tools, such as AR, VR, Mixed Reality, like Marina Abramović's digital personal avatar in *The Life* (2020), or 3D-printing, like Karin Sander's pioneering *Body Scans* (1997–2020) will lose their self-reflecting potential once we are more familiar with these technologies.[38] Oliver Grau here speaks of "media competence" and the "effect relativity of illusionism media."[39]

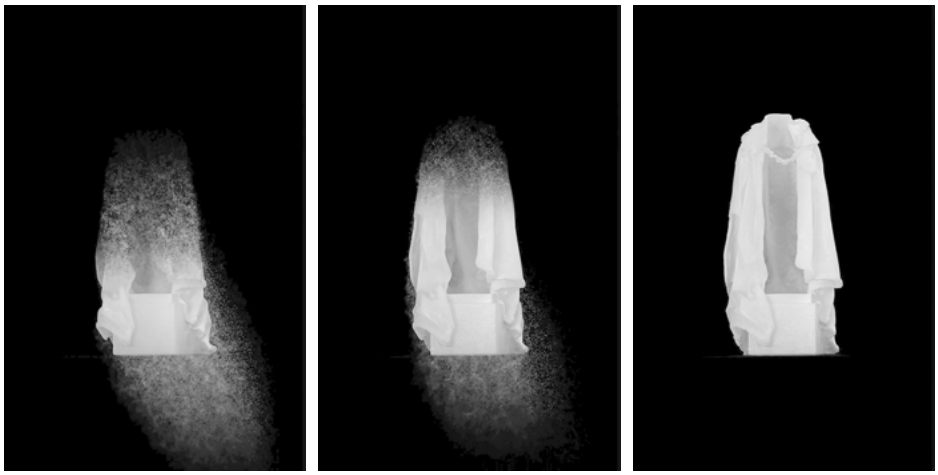
One could also think of holograms that have been welcomed by the arts in the 1970s and 1980s as a new image production method. Holograms were praised as "sculptors of

36 See https://www.radiancevr.co/artists/melodie-mousset/mousset-hanahana/; https://www.arsenalcontemporary.com/to/exhib/detail/jon-rafman; https://www.banzbowinkel.de/project/mercury/; https://news.artnet.com/art-world/jeff-koons-creates-virtual-sculpture-for-garage-magazine-91608; https://acuteart.com/artist/jeff-koons/ (accessed May 3, 2022).

37 See, e.g., https://www.skulptur-projekte-archiv.de/en-us/2017/projects/186/ (accessed May 3, 2022).

38 See, e.g., https://www.serpentinegalleries.org/whats-on/marina-abramovic-life/; https://www.karinsander.de/en/work/3d-bodyscan (accessed May 3, 2022).

39 Oliver Grau, *Virtuelle Kunst in Geschichte und Gegenwart: Visuelle Strategien* (Berlin/Bonn: Dietrich Reimer, 2001), pp. 212–13. Translation by the author.



4 Raqs Media Collective, *Hollowgram*, 2017, holographic projection, dimensions variable.

light" and "a wedding of sculpture and light," as "tangible and intangible," as shown in experiments by Simone Forti (*Angel*, 1977) or Bruce Nauman (*Making Faces*, 1968). The magazine *Holosphere* and the foundation of the Museum of Holography 1976 in New York were accompanying effects of this temporary popularity.[40] After a longer break, it seems that holograms reappear in contemporary (political) art, for example in 2017 with the *Hollowgram* by the Raqs Media Collective (fig. 4), which refers to an absent body and reminds to Auguste Rodin's *Robe de chambre de Balzac, étude* (1897).[41] Here, the lack of massiveness and stasis as well as the optically generated spatiality and plasticity are emphasized. Unlike VR, an optical, analog evoked space is created here; the illusion is only successful from a certain perspective. By means of media effects, holography produces space outside the image; the viewer is in front of the *dispositif*. Jens Schröter speaks of transplanar, planimetric images that are not based on linear perspective, for example three-dimensional images such as stereoscopic, holographic, virtual, and interactive or volumetric images.[42] But what is the materiality and mediality of such virtual, digital works and what is their ontological character as they are based on an apparatus (software and hardware)?

40 See Amy Greenfield, "Interview with Rosemary H. Jackson: Off the Wall," *Holosphere* (November 1973): 3–4. (Source: Archive MIT Museum, Collection of the Museum of Holography, New York).

41 See https://www.serpentinegalleries.org/whats-on/raqs-media-collective-hollowgram/ (accessed January 5, 2022).

42 Jens Schröter, *3D: Zur Geschichte, Theorie und Medienästhetik des technisch-transplanen Bildes* (Paderborn: Wilhelm Fink, 2009); idem., "Das transplane Bild: Raumwissen jenseits der Perspektive," in *Raum: Perspektive: Medium 2: Wahrnehmung im Blick*, vol. 2, ed. Yvonne Schweizer, Anna Quintus, Barbara Lange, Julica Hiller-Norouzi, and Philipp Freytag (Tübingen: reflex Tübinger Kunstgeschichte zum Bildwissen, 2010), idem., "Wie man Skulpturen rendern soll: Zur Geschichte der transplanen Reduktion," in Winter, Schröter, and Spies, *Skulptur – zwischen Realität und Virtualität*, 2006.

5 Banz & Bowinkel, *Mercury,* 2016–17, interactive virtual reality installation for HTC Vive.

Today, sculptural VR works enable an immersive-sensory "appropriation" of the recipient, who "wears" part of the apparatus, thus enters the digital image equipped with a head-mounted display (HMD) and moves through a virtual landscape, for example in Banz & Bowinkel's *Mercury* (2016) (fig. 5).[43] The users are confronted literally with a fragmenting, anticizing statue of Mercury that they perceive in multiperspectivity from different angles and distances, according to the individual use of the controller, offering successively changing viewing positions—or, in the words of Oliver Grau, "successively polyvariant gaze positions."[44] In contrast to traditional forms of sculpture viewing, here the avatar also can cross the statue, thus walking through it.

The *ästhetische Grenze* (aesthetic limit), as Ernst Michalski (1931) discussed it, seems to have disappeared or at least been reduced.[45] Even if his approach has been developed by looking at artworks from the eleventh century to Baroque sculpture, it seems to be a fruitful category to elaborate on within the context of digitality. Michalski understands the so-called ä*sthetische Grenze* as the "boundary that runs between formed art space and unformed free space."[46] The *Kunstraum* (art space) is the space that the artwork embraces and needs

43 One of the first head-mounted displays (HMD) has been developed since the mid-1960s by Ivan Sutherland and Bob Sproull).

44 Grau, *Virtuelle Kunst in Geschichte und Gegenwart,* 2001, p. 172. Translation by the author.

45 Ernst Michalski, *Die Bedeutung der ästhetischen Grenze für die Methode der Kunstgeschichte* (Berlin: Mann, 1996).

46 Ibid. p. 10.

by itself, by virtue of its own tendency, energy, and formal structure.[47] The unformed free space or *Realraum* includes the space of the viewer. The artwork can spill over into real space, for example in sculpture, by choosing a foot overlapping the base or a figure leaning out of the niche, such as in Gianlorenzo Bernini's figure of Gabriele Fonseca (San Lorenzo in Lucina, Rom, 1668–73). This kind of art form loses its autonomy in favor of its heteronomy. According to Michalski, one cannot speak of the "aesthetic limit" in view of architecture and arts and crafts, because they possess a reality that goes beyond the mere tangibility ("die reine Anschaubarkeit") of painting and sculpture.[48] With Bernhard Kerber, one could also think of Carl Andre's *Sculpture as Place*, which lacks a plinth and welcomes physical contact by walking on the sculpture, or of Franz Erhard Walther's performative and interactive textile sculptures.[49]

Here, in digital sculpture, one could argue that the aesthetic limit is significantly reduced in favor of its immersive character. Only eruptive image transitions and grainy resolution can disturb the spatial and pictorial illusion. Digital objects evoke different interactions in its virtual space, thus leaving pure viewability. In his analyses of early VR art works since the 1990s, Oliver Grau underlines the reduction of the aesthetic distance (*ästhetische Distanz*) and its increasing psychological, manipulative effect: "The more 'natural' the interfaces, the more pronounced not only the danger that the invisible part of the 'technological iceberg' remains closed and unconscious to its user, but above all the more intense the illusionary dissociation with the data space."[50] Or, as Derrick de Kerckhove puts it: "Through interactive media, the boundaries between what happens outside and inside our consciousness, outside and inside our body, become fluid, and soon we won't be completely sure where our body begins and where it ends."[51] In question is the border represented by our skin and the perception of digital art works, mediated by the appropriate (visual) apparatus, software, and interface. De Kerckhove has outlined touch as the essential sense of interactive media and each user's proprioception. His example is the scanning of the television screen (with the eyes) and the tactile features, such as the remote control and video recorder as historic precursors of VR. Due to multisensory responses, the whole body is addressed. According to, for instance, Gottfried Boehm, the sculptural space manifests itself tangibly on the surface of each work—the place of communication with the environment.[52] Johann Gottfried Herder's (1778) understanding of sculpture as bodily experience already indicates an increased sig-

47 Ibid., translation by the author.

48 Ibid.

49 Bernhard Kerber, "Nachwort zur Neuausgabe," in Michalski, *Die Bedeutung der ästhetischen Grenze*, 1996, pp. 287–302, pp. 295–96.

50 Grau, *Virtuelle Kunst in Geschichte und Gegenwart*, 2001, p. 183. Translation by the author. Here, he does not mention Ernst Michalski.

51 Derrick de Kerckhove, "Touch versus Vision: Ästhetik neuer Technologien," in *Die Aktualität des Ästhetischen*, ed. Wolfgang Welsch (Munich: Wilhelm Fink, 1993), pp. 137–68, p. 166.

52 Gottfried Boehm, "Plastik und plastischer Raum," in *Skulptur: Ausstellung in Münster*, vol. 1., ed. Klaus Bußmann and Kasper König (Münster: Landschaftsverband Westfalen-Lippe und Stadt Münster, 1977), pp. 23–44.

6 Banz & Bowinkel*, Palo Alto,* 2017–18, interactive virtual reality installation for HTC Vive.

nificance of plasticity in relation to the hitherto set-up hierarchies in the Paragone.[53] In the (optical) palpation of the surface, the recipients experience their own physical presence as subject and object at the same time. The binocular-stereoscopic, motion-sensitive, haptic, and corporal view also characterizes phenomenological concepts of the twentieth century. Thus, the nature of the surface—rough or polished—contributes to whether a sculpture opens or closes itself off to its surroundings. But in digital sculptures, the historically based separation and bipolar duality of the plastic-haptic and the optical-visual, as formulated by Hildebrandt and Herder, no longer applies.[54] It therefore makes a difference whether one takes an aesthetic-theoretical perspective or pursues a technical view that seeks to create mediating, cognitive, and affective interfaces.

Banz & Bowinkel's *Mercury* is only one example in which classical sculpture is used in the form of an art-historical quotation in the virtual realm. *Palo Alto* (2017) (fig. 6), another work of the artist duo, is determined by set pieces of reality, so-called *Realitätssplitter*, such as a virtual stonewall, which is juxtaposed to a blue concave-shaped mural element. Its color refers to the aesthetics of the blue screen and represents no architectural detail; rather, it annihilates a specific meaning and embodies the sitelessness or omnipresence of the internet. A general distinction must be made between the simulations of an aesthetic experience of

53 Johann Gottfried Herder, *Plastik: Einige Wahrnehmungen über Form und Gestalt aus Pygmalions Bildendem Traume,* in Herder, *Schriften zu Philosophie, Literatur, Kunst und Altertum 1774–1787*, ed. Jürgen Brummack and Martin Bollacher, vol. 4: *Johann Gottfried Herder, Werke in 10 Bänden* (Frankfurt am Main: Deutscher Klassiker Verlag, 1994), pp. 243–326.

54 Adolf von Hildebrand, *Das Problem der Form in der Bildenden Kunst* (Straßburg: Heitz & Mündel, 1910).

(a physically defined) reality and of walkable landscapes by means of a central perspective. One is reminded here of the ancient *agora*, or instead, fantastically designed spaces, including new virtual image worlds and orders without gravitational pressure.

One could ask to what extent these works reflect technological potential itself or whether they refer to an anachronistic concept of space and sculpture. Despite the dissociation between the almost non-existent movement of the viewer's body and the movement in cyberspace, the apparatus remains palpable; only the "visual aid" reveals the sculptural work. In the near future, features with haptic stimuli and collective experiences will become more developed. Nevertheless, our own knowledge and experiences of material properties, such as the stability and rigidity of marble (*Mercury*) or the rough surface of wood, still determine our perception of phenomena and sculptures in the virtual world and also determine how they affect us physically despite our consciousness of the digital illusion. This dynamic coupling of body and virtual space/image and the indiscernibility of perception and affection is an important aesthetic feature of VR.

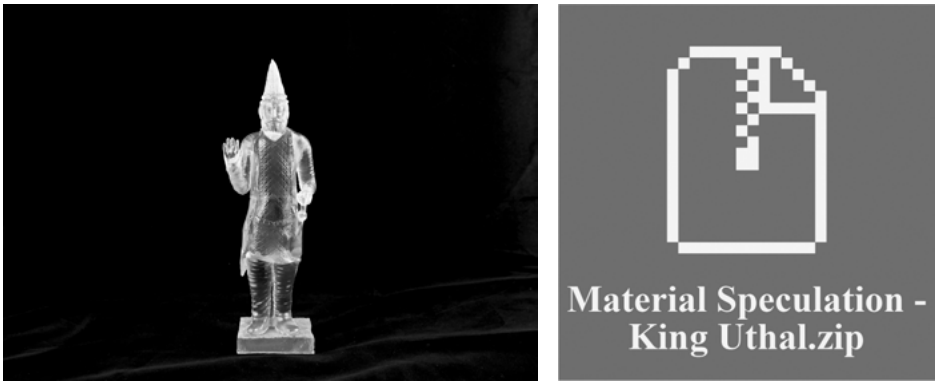
3D-Printing as Sculptural Tool: Morehshin Allahyari's *Material Speculation: ISIS* (2015–16) and *The 3D Additivist Manifesto* (2015)

Morehshin Allahyari is an Iranian, New York–based new media artist, activist, and writer. In her research-based series *Material Speculation: ISIS* (2015–16) she tried to reconstruct twelve of the artifacts at Mosul Museum in Iraq destroyed by ISIS members in front of the camera and spread worldwide in propaganda videos and press images (fig. 7). Thus, Allahyari created objects using digital modeling and 3D-printing. The Roman-period figure of *King Uthal* of Hatra, for example, is available for personal download.[55] Inside of the exhibited sculptures, Allahyari integrated a flash drive containing textual information, images, and videos about this endangered cultural heritage. Besides the lack of information, the problem of restricted access to relevant data due to commercial image policies was among the main challenges.

In her work, Allahyari explores the concept of "digital colonialism" and considers these reconstructed sculptures as "time capsules" trying to keep the memories for future societies.[56] She shows the technological and artistic potential of the restoration (and reimagination) of collective social, cultural memories within a meta-(speculative)-archeological intention. Her digital and printable simulated monuments raise questions about ethical, philosophical, and historical challenges when using automated means of investigation. Unlike "truth to materials," I would argue that these edition-like "digital monuments" interrogate established

55 See Paul Soulellis, "The Distributed Monument. New work from Morehshin Allahyari's 'Material Speculation' Series," *Rhizome,* February 16, 2016, https://rhizome.org/editorial/2016/feb/16/morehshin-allahyari/ (accessed January 5, 2022).

56 See http://www.morehshin.com/digital-colonialism-2016-2019/ (accessed January 5, 2022).



7 Morehshin Allahyari, *Material Speculation: ISIS*, *King Uthal*, 2015–16.

concepts of originality, site-specificity, and reproduction. Further, by allowing online data files (stereolithography CAD files, an early and widely used 3D-printing technology) to circulate, it loses its locality and "siteness."[57] The toppled artifacts seem to survive in their digital exile, originally printed in translucent plastic. Due to the translucent plastic, their ghost-like bodies seem to be determined by an absent materiality, evoking the visibility of the data file in the inner core of the figure. Here, 3D-processing and the posting and distributing of the files of the toppled artifacts represent a tool of artistic resistance, referring to the traditional sculptural aspect of *memoria*. Though in all likelihood it is mostly perceived by a Western public, the digital character of *King Uthal* at least allows for global perception when the corresponding infrastructures are available. What is demonstrated here is the fact that the destruction of the statues by ISIS itself generates "new" virtual statues in the form of Allahyari's an artistic response.[58]

3D-laser printing, with its simulation potential, plays a decisive role in digital sculpture: scanned three-dimensional images translated into binary codes, such as Allahyari's sculptural recreations of "digital statues" in miniature format, Karin Sander's sculptural full-body portraits, Tony Cragg's amorphous sculptures, and Matthew Angelo Harrison's 3D-printed African mask are translated back into physical facticity, into their sculpturality, in that they can be haptically experienced again when printed.[59] The location of the image is ubiquitously accessible with the appropriate apparatus, as Oliver Laric demonstrates with

57 See also the concept of nomadic monumentality as explored by Mara-Johanna Kölmel in this volume.

58 See also Ursula Ströbele, "Toppling Monuments—Media Strategies of Artistic Interventions (Alexandra Pirici, Morehshin Allahyari, Julius von Bismarck & Julian Charrière)," in *Toppling Things: The Visuality, Space and Affect of Monument Removal*, ed. Nausikaä El-Mecky and Tomas Macsotay, Brill, forthcoming.

59 See https://www.tony-cragg.com/works/sculptures/new-works/; https://www.kunsthallebasel.ch/exhibition/matthew_angelo_harrison/ (accessed May 3, 2022).

8 Morehshin Allahyari and Daniel Rourke, sound design by Andre Young, *The 3D Additivist Manifesto*, 2015, 10:11 min.

his downloadable data.[60] Reiner Maria Matysik, for his part, has been creating sculptural models of postevolutionary species since the mid-1990s.[61] His new monochrome models are 3D-printed. An included file allows reproduction of each creature. In some works, the viewer has access to an open-source data program and may change the form, thus advancing to a coauthor. These examples demonstrate the diversity of extended boundaries of tech-based sculpture in a systemic context and a relational field.

In cooperation with Daniel Rourke, Allahyari proclaims a new posthumanistic age in their film *The 3D Additivist Manifesto* (2015; 10:11 min) (fig. 8).[62] They use the 3D printer as a profound metaphor, as technology for channeling creative endeavor through digital processes. 3D-printing here embodies the primacy of creative, digital technologies, and also the simulation, synthesis, and the potentially utopian excess of algorithms that lead into a new material aesthetics of vibrant matter interfering with human organisms in a utopian way: "We call not for passive, dead technologies but rather for a gradual awakening of matter, the emergence, ultimately, of a new form of life."[63] Their manifesto is based on a

60 See https://threedscans.com (accessed May 3, 2022).
61 See https://reinermatysik.de/arbeitwork/sculpture-plastik/digital-sculpture-digitale-plastik/digitale-plastik-2/ (accessed January 7, 2022).
62 The video can be watched here: https://additivism.org/manifesto (accessed January 5, 2022).
63 See https://additivism.org/manifesto (accessed January 5, 2022).

text collage of quotations by futurists and theorists such as Donna Haraway, Rosi Braidotti, George Bataille, and Stanislaw Lem. It aims for a cybernetic interconnection of machine and human body. In the film one might find sculptural quotations and thus a significant reconnection to the history of classical sculpture, such as Marcel Duchamp's iconic ready-made *Fountain* (1917), which is representative of modern notions of art and authorship or the Hellenistic torso of the *Venus de Milo* (end of 2nd century BC), a symbol of figurative sculpture's traditional aesthetics. Departing from linear concepts in history, here, digitalized sculptural objects, industrial artifacts, technological residues, cyber bodies, and animalistic details, such as the octopus, coexist synchronously. They all float in the stream of oil, out of which they have been printed. This key material, thousands of years old, allows for innovative technologies, such as 3D-printing. Thus, the process itself refers to deep time processes. "#Additivism" is derived from "additive" and "activism" and, according to the artists, aims to disrupt existing categories, expanding the art project toward an online community, activism, ironic commentary, and revolutionary potential. Here, synthetic technology is the new modality of a biological posthuman medium, crediting intelligence to all kinds of matter.[64]

Conclusion

A number of theoretical approaches discuss the implications of the so-called "aesthetics of the digital," referring mainly to screen-based phenomena. Art history, however, pays little attention to sculptural works that are conceived and materialized using digital technologies. So, even if digital art has already its own history over a few decades, we still have to ask what terminology in art history corresponds to works, such as the above-mentioned examples. Their postmedium condition, infrastructural accessibility, and interactive features, and their various materialities, immateriality, or rather neomateriality, as well as Michalski's aesthetic limit and a form of elastic scalability, including real-time processes, are some of the main aspects that should be included in the discussion about the sculptural in the (post-) digital age.

Whereas Herbert W. Franke still uses the screen, which frames his virtual sculptures as a kind of digital canvas but already questions truth to materials, Jeffrey Shaw leaves this two-dimensionality of the display and opens his floating sculptures to the physical art space. In recent AR and VR works, the viewer is absorbed in an immersive experience with the interoceptive interiority of the body itself and travels—in the words of Wolfgang Welsch—similarly to a nomad between different forms of reality.[65] Digital sculptures, such as Banz & Bowinkel's *Mercury* and *Palo Alto*, are also characterized by spatiality, plasticity, multiperspectivity, and stasis versus temporality. However, they go beyond established sculptural parameters, questioning site-specificity and reproduction, losing their locality and "siteness."

64 Ibid.

65 Wolfgang Welsch, "Eine Doppelfigur der Gegenwart: Virtualisierung und Revalidierung," in Vattimo and Welsch, *Medien: Welten. Wirklichkeiten*, 1998, pp. 229–48, here p. 248. Translation by the author.

Computer-based 3D-printing and -scanning serve as a sculptural tool of growing interest, as well as a metaphor, such as displayed in Morehshin Allahyari's and Daniel Rourke's work. To create 3D-printed sculptures, complex translation processes take place. They operate while shifting between different forms of materiality and reality. A physical object is touched in a contactless way and scanned to allow its transfer from a digital file back to a haptic, physical object. As the examples here have demonstrated, the references to classical sculptures function as the conscious setting in relation to tradition and its discursive frame. Despite of the primacy of the visual, touch advances again to an essential sense of digital sculptures in interactive media. After all, the history of digital and virtual sculptures is a history of a media story that describes how modes of perception (still) change.