

Ornamental Images and Their Digital Occurrences

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Abstract. In the first part of this paper, the historical debate about ornamental images is summarized and interpreted. This leads to the understanding that ornamental images can be seen as a recurring phenomenon, welcomed or abolished, but always present in different occurrences throughout cultural history. In the second part, three different periods of digital technology are distinguished and ornamental images of those eras are analyzed. Based on these studies a conclusion is inferred isolating specific aspects, positioning the chosen digital examples as a continuation of a historic sequence of ornamental images.

Keywords: Digital Aesthetic, Iconic Research, Ornament, Complexity, Generative Design, Visual Communication, Practice Led Iconic Research.

1 The Historical Discourse on Ornamental Images

Ornamental objects of craft and architecture are sources of our early cultural history. They date back long before there is proof of a written discourse concerning their role and meaning. If we look at ceramic artifacts from the Pottery Neolithic (6000 – 1500 BC), the period when the ceramic technology was discovered in Mesopotamia, Asia and Europe by early societies after farming and cultivating crops had begun, we find many examples of pottery showing ornamental décor. We can only guess why the ornaments at the time have been added to the body of the pots and why the purely functional purpose of a vessel was considered to be not enough. Besides the material affirmation of the ornament, an early critical reflection upon the meaning of ornaments can be found in Aristotle's rhetoric [1]:

“Your language will be appropriate if it expresses emotion and character, and if it corresponds to its subject. ‘Correspondence to subject’ means that we must neither speak casually about weighty matters, nor solemnly about trivial ones; nor must we add ornamental epithets to commonplace nouns, or the effect will be comic, as in the works of Cleophon, who can use phrases as absurd as ‘O queenly fig-tree’.”

The ornamental is described here as an inappropriate form of speech which does not correspond to the subject and is an exalted addition to the essence of narration. This leads to an ironic and absurd expression. In the writings on poetics, Aristotle grants the ornamental a certain position among other elements of language [2]. He defines good

style in poetry as being clear without being mediocre. According to Aristotle, it is necessary to use unusual words to raise above the pure functionality of language.

“A certain infusion, therefore, of these elements is necessary to style; for the strange (or rare) word, the metaphorical, the ornamental, and the other kinds above mentioned, will raise it above the commonplace and mean, while the use of proper words will make it perspicuous.”

Without giving a definition, the description of good style asserts a clear status to the ornament by contributing to overcome the mean. In contradiction to the above quoted part of the rhetoric, the ornament does not have to be an unnecessary addition. It becomes an element with an ambiguous status denoted with positive characteristics contributing to good style, or with a negative idea as an unnecessary addition to the essential element of language.

If we leave the early rhetoric and poetic discourse behind and turn to the philosophical debate of aesthetics, Kant's *Critique of Judgement* (1790) [3] is considered one of the most influential statements about the inquiry into the beautiful. He defines the aesthetic experience as a feeling of disinterested pleasure (§26). He explains that all objects of nature can not be measured mathematically but only aesthetically and therefore we can not formulate a definite concept of what is beautiful in nature. A beautiful object has to be experienced and the senses make the evaluation. Furthermore, the aesthetic measurement is relative and is always an evaluation between objects while the mathematical measurement is absolute. Regarding ornaments we can find in Kant's *Critique of Judgment* a similar ambiguity as described above. He elaborates on the status of ornaments as follows (§14):

“Even what we call ornaments [*parerga*], i.e. those things which do not belong to the complete representation of the object internally as elements but only externally as complements, and which augment the satisfaction of taste, do so only by their form; as for example [the frames of pictures, or] the draperies of statues or the colonnades of palaces. But if the ornament does not itself consist in beautiful form, and if it is used as a golden frame is used, merely to recommend the painting by its charm, it is then called finery and injures genuine beauty.”

With this description we get closer to a definition of the ornament. It is not something necessary for the representation of an object. It does not make an object more or less recognizable in the sense of an abstracted description and it is not part of a memorized schematic generalization in order to recognize something. But the ornament contributes purely by the harmonic relationship of its form, without a mimetic function, to the satisfaction of taste as an individual experience related to a common understanding of the beautiful. In the description, a paradoxical evaluation becomes apparent again. If the ornaments are isolated from the essence of the content they have a negative effect and become empty forms inhibiting the aesthetic experience.

Considering this two-folded idea of the ornament, the elaboration on painting is even more surprising. In paragraph 51 of the *Critique of Judgement* Kant discusses the division of the beautiful into subsections. The division can be made into artificial aesthetic ideas and natural aesthetic ideas. He considers the division into two categories, the art of expression of thought and the art of intuition, but he refused this possibility as too abstract. He preferred to divide the beautiful into three areas; the art of

speech (rhetoric and poetry), the art of form and the art of playful sensations (color and music). The formative art consists of the plastic art and painting. Painting is defined as an aesthetic experience resulting from a mimetic function or the arrangements of natural or artificial objects in a repetitive manner such as in landscape gardening. Painting proper is creating an illusion in the beholder through its mimetic function stimulating imagination, whereas the arrangement of decorative elements are fostering imagination purely by the relationship of their forms. But the ornamental painting and painting proper follow the same goal to foster imagination as a free process of thought in the beholder. According to Kant, the judgment of taste depends in all the arts on the effect of form in regard to imagination. In this definition, the ornament is assigned an independent role and leaves behind its irrelevance as an addition to an essential experience.

Other aspects of the ornamental were developed by Karl Philipp Moritz (1756 – 1793), just shortly after the Critique of Judgment had been published. Moritz was appointed in 1789 as a professor for antiquity at the Royal Academy of Fine Arts in Berlin, where he lectured students who studied fine and applied arts. In his publication “Pre-Terminology for a Theory of Ornament” [4], Moritz does not complete a reformulation of the ornament. Even though we have to consider his publication as a preliminary stage for a fully developed theory prevented by his death in 1793, we find a range of terms presenting the ornament under a new point of view. Already in the introduction, the analogy of perceiving nature such as leaves of a tree and looking at decorations (Zierrath) is described as equal in evoking mental processes (p. 4). Furthermore, to decorate is described as a uniquely human drive as important as the drive to do science or art (p. 5). In the discussion of the bodily occurrences of humans and animals, the terminology *Uniformity* and *Variety* provide a starting point to understand the ornamental repetition in nature and art as a result of a common principle of creation which leads to harmonious occurrences (p. 11). The ornament can be understood therefore in a psychological reading as a longing to understand the principles guiding the process of creation. In this context, terms such as *Imitative Instinct* and *Addiction to Innovation* used by Moritz, refer to the creative context and can be read as two methods to come up with unseen images (p. 56). Even though the idea is not elaborated on in great detail, Moritz addresses the question of when form is merely a variation of some known and existing image, and when does a form overcome being a mere alteration within a given principle?

We have turned now already to the processes of image creation and left behind the ornament debate which is led purely by the effect of the image on the beholder. Gottfried Semper (1803 – 1879), architect and art critic, has emphasized the influence of the technique and material quality on the crafts. In his elaboration on the cultural development he declares weaving as the starting point from which all handcraft, art and architecture originated. He considers weaving of fences and textiles for clothing to be closely related to the first occurrences of the ornament. The orthogonal structure of warp and thread are according to Semper responsible for the discovery of an ornamental décor as a result of simple alterations in the weaving process [5]. The recognition of the effect caused by rhythmic abstract compositions in textiles are declared by Semper furthermore, to be the springboard of art in general (p. 113). While Semper intends to prove the influence of weaving technique and materiality on other crafts, art and architecture, Alois Riegl (1858 – 1905) refuses the exclusive focus on these

two components. In his “Historical Grammar of the Visual Arts” he defines the origin of Art in the human drive to imitate nature. Symmetry and rhythm are, according to Riegl, not merely an effect of the “Medium” (materiality and technique) but existed already before weaving was invented as a basic human drive to imitate nature. As inference of this idea, Riegl attempts to connect historical and cultural contexts through the occurrence of comparable ornamental motifs [6] [7].

The re-occurring focus on ornament throughout the centuries, selectively summarized above, is proof of the intriguing power of this iconic phenomenon. At first glance it seems that the modern movement of the 20th Century has banned the ornamental for reasons expressed in Adolf Loos’ polemic essay “Ornament and Crime” [8]. A closer look at facades realized by modern architects (Mies van der Rohe, Marcel Breuer, le Corbusier) [9] or paintings by modern artists (Piet Mondrian, Wassily Kandinsky, Jackson Pollock) [10], show a new ornamental aspect which is caused by repetitive visual elements and their various alterations. In reference to George Kubler and his description of cultural development as a sequence of occurrences originating from a common problem [11], we can describe the ornamental image as a linked sequence of solutions to the question of how imagination and aesthetic experience can be stimulated (Kant) or how a principle of creation can be visualized (Moritz). The following analysis of digital images with an ornamental structure is based on the issues of analog images described above.

2 Ornamental Images in the Digital Age

If we turn now to the analysis of digital ornaments we can refer again to Gottfried Semper’s idea of defining a work of art or craft as the result of its function, the characteristics of the material chosen for the object, and the tools involved in the process of design. Even without the support of these three points as exclusive influences on art and design, we find an analogy in the famous formula “The medium is the message” by Marshall McLuhan pointing at the dependence of form on the medium [12]. Functionality of the message can only be achieved within the medium (materiality, tools). The following analysis of digital ornament examples is conducted with the aim to describe the shift of the phenomenon within the constraints of digital technology.

2.1 Ornamental Images in the Pioneering Phase of the Computer Era

During 1965, three exhibitions of computer-generated images were shown [13]. Georg Nees presented his work at the Technical University Stuttgart in February. The work of Michael Knoll, generated since 1961 at the Bell Laboratories in Murray Hill New Jersey, was exhibited in April at the Howard Wise Gallery, New York. Frieder Nake had a show with his images in November at the Gallery Wendelin Niedlich in Stuttgart. The results of these early experiments are proof of inquiries exploring the possibilities of image generation through computer code. Looking at these images, it is evident that the computer artists were interested to explore whether the programmed image is able to imitate the individual stroke of an artist. In Frieder Nake’s work “13/9/65 Nr. 2” (also known as *Hommage to Paul Klee*, 1965, plotter

drawing, ink on paper) or Michael Noll's "Four computer-generated random patterns" (based on the composition criteria of Mondrian's "Composition with Lines", 1965), the orthogonal structure of the images is dominant. Both image series imitate a repetitive flow of gestures by the randomized variation of a basic description of a specific form. In this alteration of a principle, the images become ornamental in the sense that they show unity and variety based on a common underlying principle. The beholder perceives a variety of similar forms related to each other but they can neither be recognized as mimetic representation of an object, nor as signs pointing to something. We can describe the mentioned images as second generation artwork merely created to find the limits of the technical capabilities of the computer with the literal meaning of Max Bense terminology "artificial art" [14].

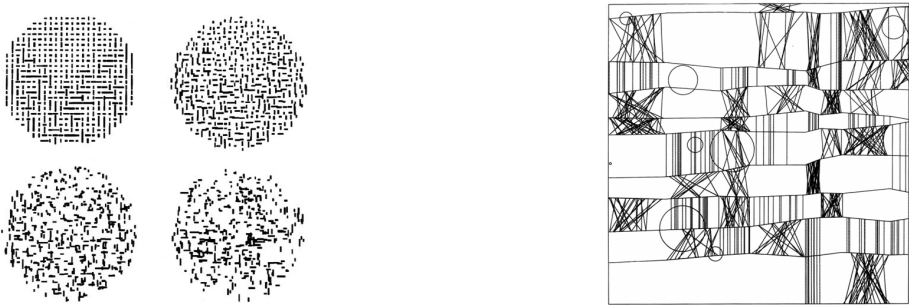


Fig. 1. Left: Michael Noll: Four computer-generated random patterns based on the composition criteria of Mondrian's "Composition with Lines", 1965. Right: Frieder Nake: 13/9/65 Nr. 2, Hommage to Paul Klee, 1965. Digital Art Museum, DAM, (www.dam.org).

In contrast to the work of art generated with traditional means, the computer generated ornamental image lets us access the underlying principle in the form of programming code and unveils to a certain degree the mystery of a creative process. Guided by the fascination of mastering a principle of creation in nature through a mathematical description, a second category of images can be distinguished. The image "Gravel-Texture" (Schottertextur) by Georg Nees from 1968 shows a sequence of twelve squares from a geometric, horizontal alignment at the top to a scattered arrangement of the squares at the bottom of the composition. We can imagine a sequence of square objects exposed to external powers gradually disintegrating the orderly arrangement. Even though we can not say what the squares depict, we can follow the imitation of a process we are familiar with from the experience with physical objects. The title of the project confirms and supports the reading of the image. Georg Nees' image series "Octagons" (8-ecke) also represents a variety of similar possibilities to connect eight points through lines. With the systematic arrangement, the beholder is overseeing a field of options and can compare the variations, perceiving similarity and difference.

Both images "Gravel-Texture" and "Octagons" explore randomly generated values in order to imitate natural variety. The lack of curves is obvious in these early images realized by computer code. They can be declared as ornamental with a number of

arguments: (1) The most obvious argument is based on the observation that the compositions consist of elements used in a repetitive way varying in position or form. (2) Both images provide an aesthetic experience through the ambiguity of their meaning. A direct mimesis and denotation of the forms are missing. (3) The images are ornamental because they present a principle of generating variety by following a natural process. (4) The mathematical description of the principle becomes accessible and repeatable in these generative processes. The creation of images becomes a repeatable process such as an experiment in the sciences.



Fig. 2. Left: Georg Nees: Gravel-Texture (Schottertextur), 1969. Digital Art Museum, DAM, (www.dam.org). Right: Georg Nees: Octagons (8-ecke), 1964. compart, center of excellence computer art, (<http://dada.compart-bremen.de>).

The Fractal images emerging in the beginning of the 1980's can be seen as a further development to imitate and recreate an underlying principle of nature with a mathematical code. Benoît Mandelbrot discovered the equation named after him in 1979 and his visualizations of the mathematical discovery allowed a popular understanding of self-similarity as a principle in nature [15]. The visualizations mark a peak of the confrontation between the natural and the artificial. Their broad reception in science and art is an indicator of the basic longing for the understanding of the powers behind nature and other complex systems found in risk management or economy. The self-similarity of these images at different levels of zoom, makes them a unique type of ornamental self-reference, and complements the idea of randomly generated variety of the earlier computer graphics.

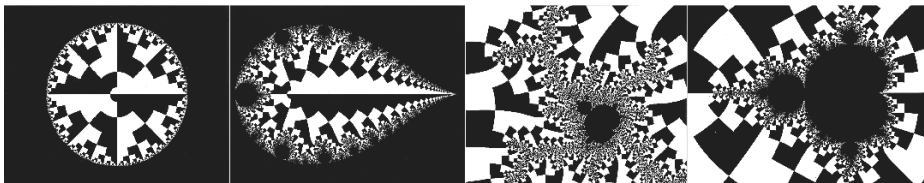


Fig. 3. Heinz-Otto Peitgen, Peter H. Richter: Binary decomposition, 1986. The Beauty of Fractals. Images of Complex Dynamic Systems, p. 74, Berlin 1986.

2.2 Ornamental Images in the Early Stage of the Personal Computer

In the exhibition of Georg Nees' work at the ZKM in Karlsruhe 2006, there was a small woven carpet exhibited consisting of black and white stripes. Nees had woven the carpet on a children's loom altering black and white according to the toss of a dice. It was his interest in randomly generated images that lead him to the loom [16]. In reference to Gottfried Sempers idea of situating weaving and its orthogonal structure as the beginning of the ornament, we can also consider the computer-generated images in the phase of the emerging personal computer technology in the mid 1980's under the aspect of the ornamental. The aesthetic of the early drawing software is strongly influenced by the orthogonal structure of the pixel-raster. In contrast to the programmed images which were executed with an automated drawing table (Zuse Z64 Graphomat) moving a pen over paper, the technology as an affordable output device, connected to the personal computer, was the dot matrix printer. As the name of the printer conveys, any image executed with this technology follows a matrix based on pixels. Experimental investigations were made by designers and artists to explore the new possibilities of the digital tools. The wrapping paper designed by Mara Jerman in 1985 at the Basel School of Design is a typical example that integrates the dot matrix aesthetic with a project [17]. In opposition to the work achieved by programming code, the aesthetic of the software tools does not address the concept of presenting a field of options by varying the execution of one algorithm. The images are rather examples of collage in which textures of different density, gestural strokes drawn with the mouse, and typographic elements are composed through the possibilities of the copy and paste functions provided by the software. Since the pixel was at that time a one bit (binary digit) entity, textures were employed to achieve a gray scale effect. The MacPaint interface from 1984 shows the matrix was not only used to fake grayscale but also to offer a palette of textures and patterns. Once they were filled into a shape, the designer could alter them according to his/her imagination. These possibilities, provided by the software, allowed a free combination of existing and self generated ornamental textures and patterns. They have fostered the use of ornamental elements along with the promotion of a combinatory process provided by the copy and paste function [18].



Fig. 4. Mara Jerman: Wrapping paper for citrus fruits designed with MacPaint, 1986. *Swiss Typographic Magazine* 4, p. 3 – 18, Zürich 1986.



Fig. 5. Susan Kare: Drawing in MacPaint for the release 1.0 of the MacPaint software, 1984. Wikipedia, (<http://en.wikipedia.org/wiki/File:MacpaintWP.png>).

The addition of low cost scanners to the personal computer made it possible to scan photographic images as bit map images, imitating gray values with a larger or lower density of a randomized pixel texture. Depending on the setting of the resolution, more or less abstraction was achieved. In the following test sequence of transferring a continuous tone image into a bit map, we can perceive a diminishing role of the mimetic and an increase of the self-referential function of the squares with decreasing resolution. In this technical process of abstraction, the ornamental is a principle applied to the conversion of gray values without paying attention to the mimetic aspect of the represented object.



Fig. 6. Amir Berbic: Systematic reduction of the bit map resolution applied to a portrait photograph, Summer Workshop 2009. Archive of the Basel School of Design HGK FHNW.

2.3 Ornamental Images in the Beginning of the 21st Century

The further development of standard software and authoring tools enable designers today to choose and to combine the processes of digital image generation described

above. The resolution of the image description, as well as the input and output devices are no longer prescribing an orthogonal structure onto design solutions. Generative processes defining procedures of image generation and standardized software tools can be combined more or less *ad libitum*. If we see the ornamental image not purely as a result of materiality, tools and techniques, but also as a means to accommodate a specific need of the beholder, we can ask again what kind of digital images with an ornamental effect have been created with the actual technology. Three examples are discussed in the following section which stand for a continuation of the historic sequence of iconic phenomenon of ornament.

The thesis project of Simon Koschmieder conducted at the Basel School of Design (HKG FHNW) in 2004, explored the possibilities of an interactive installation in public space. The installation was designed to engage people in the play of image generation. The interaction with the image generating hardware and software was based on the interpretation of sound level, movement, and color. Live video footage was captured, interpreted, and altered through processing code [19] and the resulting images were projected onto a large wall of the space. The alterations of the video image can be grouped in three categories. (1) The captured image is interpreted according to a set of rules applied to a grid. In the specific case each square was filled with a color sample of the underlying life image. Furthermore, the squares were divided diagonally and the darker the section of the life image, the larger the area of the gray overwriting of the actual color became (Fig. 7. left). (2) A sequence of live images was displayed and continuously updated. Through the small interval of the frames captured and the gradually changing orientation of the frames, the projection was read as an assembly of transforming elements (Fig. 7. middle). (3) The third interpretation of the life captured video image was transformed in a way that the mimetic function of the image was completely lost. The interpretation of video data resulted in a repetitive composition of similar but never equal elements (Fig. 7. right). Something all of the discussed images have in common, is that the ornamental effect is achieved by a repetition which is addressing the flexibility of a formal principal (not principal). It is not the square pixel, nor the imitation of a natural variety, but an abstract play of similar forms and their relationship presented through dynamic transitions which is characteristic for these images.

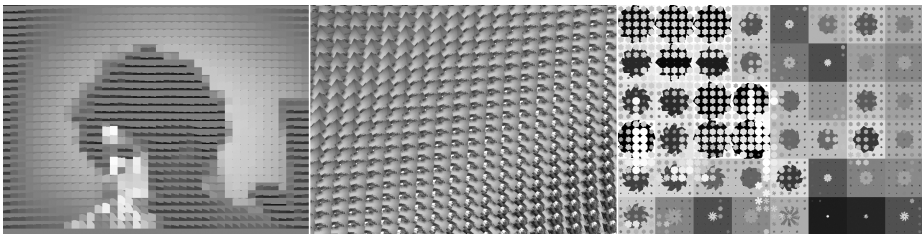


Fig. 7. Simon Koschmieder: E-Walls, Thesis 2004. Archive of the Basel School of Design HKG FHNW.

Another example is the image series “Path” by Casey Reas. He describes the images as a movement of a synthetic neural process [20]. They are characterized by repetitive lines which are similar to hand drawn marks in their variation and unity. In

their organic flow, they remind one of colored ink dissolving in water. As the title confirms the images are meant to imitate an originally natural process of neurons. We can explain the image series “Path” with the aim of ornamental images to address a principle of nature showing variation and unity. As described above, this aspect was the first time addressed by Carl Philipp Moritz and is also apparent already in the early stage of programmed images. It is the fascination of artificial nature which is further developed in the images of Casey Reas through the mastering of curves and the resulting organic shapes achieved in his and Ben Fry’s programming platform “Processing” [19]. Furthermore, the specification of “Path” as a movement of a synthetic neural process is pointing to another characteristic of digital ornaments. A synthetic neural process is most likely described by an immense amount of data indicating which neuron is activated at what time. The design of images based on data has become increasingly available through the possibilities of data storage and processing.

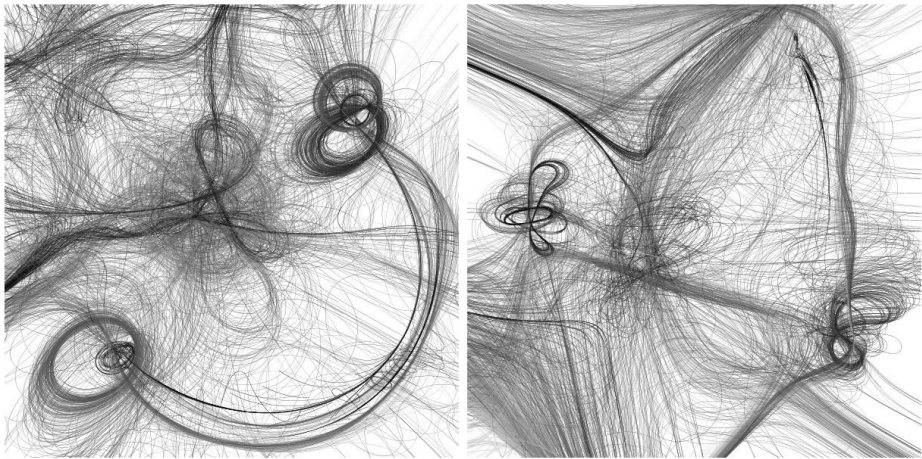


Fig. 8. Casey Reas: Path, 2001, (<http://reas.com/>)

The project “Big Atlas of LA Pools” conducted 2013 by Benedikt Groß and Joseph K. Lee [21] has isolated 43,000 swimming pools of the Los Angeles area from digital maps publicly available. They have used online services such as “clipping farm” or “amazon mechanical turk” to isolate, locate, verify and assemble pools to a thematic atlas of Los Angeles. This procedure generates images that pretend to visualize information. The amount of data – in this specific case the shapes of the pools – appears as a repetitive accumulation of similar shapes causing an ornamental effect. Only with a closer analysis can we perceive that there are not many small pools, midsize pools seem to be more rounded and large size pools are often organic. But the reading of the midsize pools might just be an effect of the accumulation of lines and is not clearly inferable from the image. We may understand this kind of information visualization as a “data ornament”. It is characterized by an overwhelming accumulation of similar entities creating a loss of significance of an individual measurement in the visualization.

The design decisions do not follow the aim of reduction or explanation of a complex situation, but rather follow the aim to create an aesthetic experience or even achieve the experience of the sublime in the beholder [22].

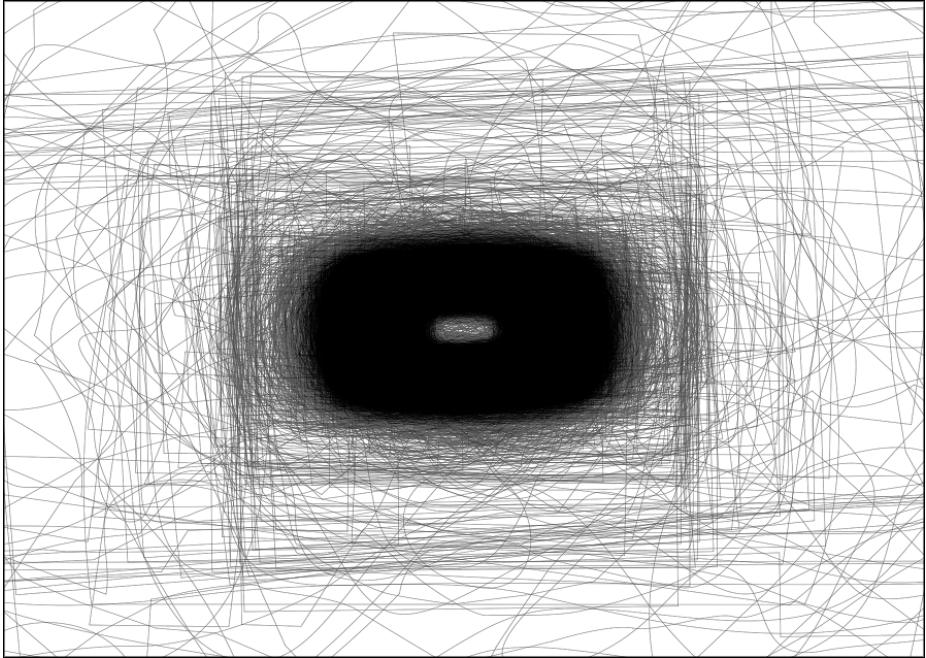


Fig. 9. Benedikt Groß, Joseph K. Lee: The Big Atlas of LA Pools, 2013, (<http://benedikt-gross.de/log/2013/06/the-big-atlas-of-la-pools/>)

3 Conclusion

In the first part of this paper the theoretical discourse about the ornament has been summarized briefly. The ambiguity of the ornament as a negative and unnecessary addition or a core element of an aesthetic experience has been addressed. Furthermore, the ornament has been identified as an image category representing a principle of creation in nature as well as in art and design.

Referring back to the continuation of the historical sequence of the ornament, we can identify the following points as achievements of the digital image generation processes: In the early era of programmed images, the confrontation of the natural, which is visible in the output, and the artificial, which is recognizable in the mathematical description in a form of the computer code, has found a new form which can be interpreted as a continuation of representing unity and variety (Karl Philipp Moritz). In the early phase of the personal computer textures with orthogonal structures can be seen as another revival of textile design principles. But they overcome these constraints through the technical possibilities of combination and figuration leading to collage-like compositions. In the 21st Century, the ornamental image is no longer bound to repetition of a static form.

Variety is achieved by generative procedures calculating the individual instance of an element from a set of live data coming from a flow of images or a dynamic data stream captured in a digital network.

With these observations we can infer the fruitful continuation of the historical sequence of ornamental images in the digital era. The digital occurrences relate to their analog ancestors and at the same time overcome them with aesthetic innovation.

References

1. Aristotle: *Rhetoric*, translated by W. Rhys Roberts, Mineola NY, book III, paragraph 7, p. 129 (350 B.C.) (2004)
2. Aristotle: *Poetics*, translated by S. H. Butcher, Mineola NY, Part XXII (350 B.C.) (1997)
3. Kant, I.: *Critique of Judgement*, translated with Introduction and Notes by J.H. Bernard, 2nd revised edn., London (1914), <http://oll.libertyfund.org/title/1217> (January 19th, 2014)
4. Moritz, K.P.: *Vorbegriffe zu einer Theorie der Ornamente*, Berlin (1793)
5. Semper, G.: *Style in the technical and tectonic arts, or practical aesthetics*, translated by Harry Francis Mallgrave and Michael Robinson, Los Angeles (1879, 2004)
6. Riegl, A.: *Problems of Style*, translated by Jacqueline E. Jung, New York (2004)
7. Riegl, A.: *Historical Grammar of the Visual Arts*, translated by Evelyne Kain, Princeton (1993)
8. Loos, A.: *Ornament and Crime*, translated by Michael Mitchell, Riverside CA (1904, 1998)
9. Picon, A.: *Ornament: The Politics of Architecture and Subjectivity*, London (2013)
10. Brüdelin, M.: *Die abstrakte Kunst des 20. Jahrhunderts oder die Fortsetzung des Ornaments mit anderen Mitteln. Die Arabeske bei Runge – Van de Velde – Kandinsky – Matisse – Kupka – Mondrian – Pollock und Taaffe*. In: Beyer, V., Spies, C. (eds.) *Ornament. Motiv – Modus – Bild*, München, pp. 349–374 (2012)
11. Kubler, G.: *The Shape of Time. Remarks on the History of Things*, New Haven/London (1962)
12. McLuhan, M.: *Understanding Media: The Extension of Men*, Cambridge (1994)
13. DAM, Digital Art Museum (February 1, 2014), <http://dam.org/artists/phase-one/frieder-nake>
14. Bense, M.: *Aesthetica. Einführung in die neue Aesthetik*, 2nd edn., Baden-Baden, p. 337 (1982)
15. Mandelbrot, M.: *The Fractal Geometry of Nature*, New York (1982)
16. Video-documentation of the exhibition “Georg Nees – The Great Temptation) at the ZKM Karlsruhe (2006), http://www.youtube.com/watch?v=CRVCX2A_YUA (February 1, 2014)
17. Jerman, M.: *Wege zur Typographie*. *Swiss Typographic Magazine* 4, 3–18 (1986)
18. For another typical example see: April Greiman, *Design Quarterly* 133, *Does It Make Sense?* Walker Art Center, Minneapolis (1989)
19. Processing web site, <http://www.processing.org> (February 1, 2014)
20. Reas, C.: http://reas.com/path_p/ (February 1, 2014)
21. Groß, B.: <http://benedikt-gross.de/log/2013/06/the-big-atlas-of-la-pools/> (February 1, 2014)
22. Kant, I.: *Critique of Judgement*, translated with Introduction and Notes by J.H. Bernard, 2nd revised edn., § 25, London (1914), <http://oll.libertyfund.org/title/1217> (January 19, 2014)