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Apophenia and Celestial bodies: Ancient origins of the pixel

Topic: Art History

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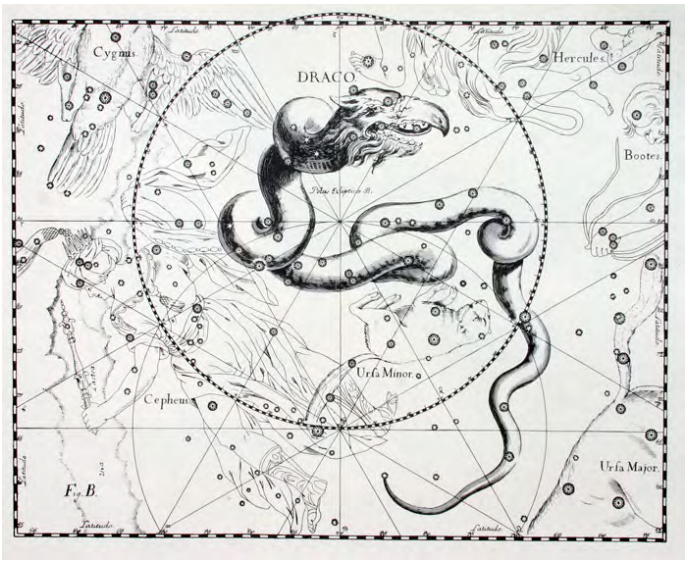
Abstract:
Despite popular perception, the pixel, the smallest visible element used in digital expression, actually has a history that goes farther back than most of us realize. Although, contemporary generative art has evolved from the coalescence of artistic practices and technology, it is the added innate function of the human brain to form meaningful imagery from a variety of visual stimuli that has provided the primary environment in which the pixel is employed.

Though a pixel can be viewed merely as a container for smaller digital elements (for example RGB color values), it is the smallest visible component a viewer interacts with in the digital world. It is the role of the pixels in a collection to provide the viewer with the necessary information required to create a meaningful image. The human brain has an incredible capacity to link, reference, and formulate meaningful structures from visual information even where the stimuli is limited, selective, random or meaningless. This is a phenomenon known as apophenia.

Utilizing apophenia as the vehicle for exploration, this paper will trace the trajectory of pixel evolution from Bronze Age Mesopotamia (~1500 BC) through the early 20th century. The purpose of this investigation is to not only establish the greater history of the pixel in image construction, but to provide a greater context for understanding the inherent modes of human perception and how these ideas interact with, inform, and alter our experiences with works of generative art.

Example: Draco (constellation) by Johannes Hevelius, 1690, illustrates the human capacity to generate meaningful imagery from a collection of random 'celestial pixels'



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Pixels from Heaven: Apophenia and the Ancient History of the Pixel

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Abstract

Despite popular perception, the pixel, the smallest visible element used in digital expression, has a history that goes farther back than most of us realize. While contemporary generative art has evolved from the coalescence of artistic practices and technology, it is the human brain's ability to create comprehensible imagery from a variety of visual stimuli that provides the primary environment in which the pixel is employed.

Although a pixel can be considered simply as a container for smaller digital elements, it is the smallest visible component a viewer interacts with in the digital world. The role of pixels in a collection is to provide a viewer with the necessary information required to create a meaningful image. The human brain has an incredible capacity to link, reference, and formulate coherent structures from visual information even in cases where the stimuli are limited, selective, random or meaningless. This phenomenon is known as apophenia.

Utilizing apophenia as the vehicle for exploration, this paper will trace the trajectory of pixel evolution from Bronze Age Mesopotamia (~1500 BCE) through the early 20th century. The purpose behind this investigation is to not only establish the greater history of the pixel in image construction, but also to provide a greater context for understanding the inherent modes of perception and how these ideas interact with, inform, and alter our experiences with works of generative art.

Introduction

Over the past four thousand years, the imagery found and generated within mediums as varied as the heavens, paintings, television and computers all share a common component – the pixel. It is the minutest and simplest element in any image. The definition of pixel or picture element varies in interpretation based on the context of the media or apparatus used, but in all contexts it is the smallest controllable visual component in a given display space. As such, it has played an extraordinary role in the advancement of image representation, information transmission, color theory, and even the development of a unique pixel aesthetic in the digital art world and traditional art practice.

In this paper I will discuss how the modern pixel and its related aesthetical characteristics were founded in ancient celestial apophenia, and further, how the role and use of the pixel has evolved through both traditional and technological art forms. Additionally, I will provide a short historical survey of artwork illustrating the evolution of the pixel-aesthetic, and how this foundation is being utilized in modern generative art practices. Finally, I will explore the future of the pixel as an essential artistic tool in the digital arena of visual art production.

Ancient History of the Pixel

Mesopotamia (~1500 BCE)

Given that nearly every image is merely a composition of points, lines, and planes [1], the pixel theoretically is evident in nearly all forms of visual art. The key characteristics of the pixel are: one, that we usually observe it as an illuminated point, and two, that a series of pixels are required for the formation of an identifiable image. Similarly, these two characteristics are present in the celestial identification of the constellations. Understanding that stellar constellations are illuminated points forming meaningful images on a night sky is an important step in relating how images are formed within our minds, and how we use these points to transmit information. One of the fundamental roles of a pixel beyond its contribution to an image's make-up is its ability to relay information. Whether it is the red, green, and blue values in our digital displays or the location of the North Pole, the pixel serves several functions. Sky-maps used in ancient Mesopotamia and the Mediterranean around 3200 BCE were mnemonics primarily used for time and calendar keeping, navigation, and farming [2]. Despite this, it was the physical documentation of the first zodiac constellations in Mesopotamia around 1500 BCE where the first pixels received life in recorded form; these images were the most likely source for the Greek classical constellation maps of the sky found around the 5th century BCE [3].

Greece and Rome (~500 BCE to ~200 CE)

Figure 1. Aion, god of time with Zodiac (detail). Central part of a great floor mosaic from a Roman villa. ca. 200–250 CE.

As constellations developed and sky-maps became more uniform, the Greeks developed a more formal set of 48 constellations from the various traditions, including images of the zodiac [4]. However, images of the zodiac were not restricted to the sky, artistic development during this period found their way into mosaics. The mosaic is a large image composed of smaller particles, whether they are pebbles or colored glass, and mosaic tradition is one of the earliest examples of pixelated art (Figure 1). Ancient mosaics were not typically rigidly aligned, nor were they structured in the gridded formation of our modern digital displays, but they did provide the creative foundation that the digital mosaic of the 20th century would eventually build upon.

Iran (1000 CE)

In terms of pixel-related characteristics, the next evolution of the pixel/point occurs in the 9th century CE when the concepts of atomism found in Islamic art and architecture coincided with our modern application of the pixel. Whether the elaborate construction of *muaqarnas* domes or the Islamic calligraphy built on the standardized element of an individual square or rhomboid, media theorist and artist Laura Marks establishes that these characteristics form “a strong parallel in computer-based media that makes it impossible to know the relationship between pixel-based image and underlying software” [5]. This theoretical framework is also evident in Kandinsky’s distinction of the line as merely a collection of connected points [1], yet another reflection of how constellations are representative of spatially distributed pixels in the sky connected through the apophenic capabilities of the human mind.

Modern History of the Pixel

Traditional Art Media

There is a paradox that exists in the visual arts when discussing the pixel as an artistic component of art production; it is a paradox born of synchronicity. The pixel in the modern sense is a digital element, used far more often in technology than in the traditional art world. However, the evolutionary trajectory of the electronic pixel coincides with the development of divisionism (also referred to as *chromoluminarism*) in painting. Because these two mediums evolved relatively independently up until the 1960s, I believe it is more practical to investigate them individually.

From an art world perspective, the origins of the modern pixel aesthetic emerged with Georges Seurat and Paul Signac in the 1870s. Their creation of pointillism is heavily reliant upon the concept of divisionism – a style of painting that relies on the optical mixing of separated individual dots or patches of color [6-7]. The breaking apart of the picture into individual components was a vital step not only in the theory of color and optics, but was instrumental in the development of abstraction and a rethinking of what composes a picture. Divisionism, therefore, was at the forefront of

a deconstructionist movement in the art world that included other art forms like cubism, fauvism, and Dadaism. In addition to this separation of an image's components, the use of systematic and mechanical instruments also came into popular use with artists. One of the most common tools early artists utilized was the grid, not just as a guide but as a formal construction element and critical visual component. An early example of imagery produced with a grid and separated color or tonal elements can be found in the work of Jean Arp and Sophie Taeuber. For example, "*Duo Collage*" (Figure 2), despite being Dadaist in its construction, is inseparable from the "historical context of mechanization that […] gave rise to [its] creation" [8]. In this way, the grid further pushed art imagery towards a foundation that is shared with digital media. Over the past hundred years artists have been exploring the grid and solid color segregation in numerous ways, one of the best examples of this early form of the pixel aesthetic can be found in the work of Ellsworth Kelly.

The deconstruction/construction and abstraction of color and the diagrammatic has become a very prominent feature in modern art – from early artists like Piet Mondrian to contemporary artists like Chuck Close. The use of the gridded element frame or cell is as firmly rooted in contemporary artistic practice as it is in the current digital world. Perhaps one of the earliest artists to create artwork that utilized both the grid and solid color blocks is Ellsworth Kelly. In Figure 3, Kelly's arrangement of random color swatches is so visually related to 8-bit computer graphics that it is hard to believe this work was created close to 40 years before computer graphics were utilized in an artistic manner. It is the deconstruction and abstraction of traditional artistic elements and the greater use of mechanical tools and systemic approaches to art creation that has allowed artists to develop a unique aesthetic that is now further enhanced by the digital world. In fact, it is this diagrammatic abstraction that Buchloh describes as being…

"the one variety […] that explicitly recognizes externally pre-existing systems of spatio-temporal quantification or schemata of statistical data collection as the necessary and primary matrices determining a pictorial/compositional order […] And while the diagrammatic would most likely operate in tandem with these other matrices, it would be sufficiently differentiated to be recognizable as a distinct episteme within the highly differentiated gamut of non-representational painting." [9]

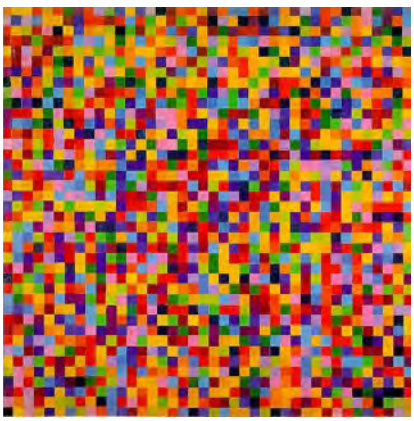

Figure 2. *Figure 3.* *Figure 4.*

Figure 2. Jean Arp and Sophie Taeuber. Duo Collage. 1918.
Figure 3. Ellsworth Kelly. Spectrum Colors Arranged by Chance III. 1951.
Figure 4. Gerhard Richter. 4900 Colors: Version V, Plate 9 of 10. 2007, Fondation Louis-Vuitton pour la création, Paris.

With respect to Gerhard Richter's "4900 Colours" (Figure 4), Buchloh's discussion exemplifies what makes Richter's presentation different from Kelly's. At the same time his observation can easily be extended to digital art and more specifically the pixel-aesthetic. Richter's "4900 Colours" are panels of isolated color blocks that appear to be random, but his color arrangement is actually determined by computer prior to being rendered in enamel and plastic. This work could have easily been produced digitally, as the final visual exhibition is very demonstrative of the pixelized world common to low resolution digital imagery. Richter's use of the computer as a tool to assist the random assignment of each color's location makes this work rather ironic when considering that the end result is not just facilitated by a computer, but is itself visually representative of the digital world. From Arp to Richter this short survey of how the pixel aesthetic has evolved in modern art is only a small selection of a much larger history of artists (including Joseph Albers, Agnes Martin, Piet Mondrian, and Frank Stella – see figure 5) who explored the distinctive realm of the diagrammatic that gave rise to an aesthetic that bridges traditional art with our new technological age. This is an important aspect in understanding the role that traditional art plays in this new aesthetic and is essential knowledge to consider as we look at the evolution of the digital pixel and the way these two seemingly separate disciplines have amalgamated into one unique aesthetic movement.

a. **b.** **c.** **d.**

Figure 5. ***a*** *– Josef Albers. Gitterbild (Lattice Picture, Also Known as Grid Mounted). 1921, Tim Nighswander/Art Resource, NY;* ***b*** *– Agnes Martin. Wood I. 1963, Gift of Sally and Wynn Kramarsky, The Museum of Modern Art, New York;*
c *– Piet Mondrian. Broadway Boogie Woogie. 1943, The Museum of Modern Art, New York;* ***d*** *– Frank Stella. Double Gray Scramble. 1973. Gemini G.E.L., Los Angeles, Museum of Modern Art, NY.*

Digital Art Media

Although the term 'pixel' has only been a part of our modern lexicon since the 1960s [10], its conceptual origin coincides with Seurat's development of pointillism. The "*bildpunkte*—literally picture points" [10], was used by German photographer

Hermann Vogel in the 1870s, and was first described in print in Paul Napkow's German patent for the "*Elektrisches Teleskop1*", the first electromechanical television, in 1884 [11]. Even though these two conceptual frameworks would not come together until several decades later, I believe it is important to note that the modern pixel was actually developed synchronously with pointillism/divisionism and abstraction and is not an invention of the modern computer age. The continued deconstruction and abstraction of the picture in the visual arts early in the 20th century was a crucial step to the future marriage of the *dot* as an artistic device in digital media. Digital art as we know it today is actually the result of over a hundred years of creative exploration and innovation in both the art world and technology. It is worth noting that the introduction of divisionism thrust the painted *pixel* into existence through deconstruction whereas *bildpunkte* is a component required for the construction of an image in a new electronic medium. The pixel is typically considered to be "the smallest single component of a digital image," but it's true definition is very much subject to the context in which it is used. Although "aesthetic theories suitable […] for computer art [were] still in their infancy" [12] in the 1970s, without the development of these theories the use of the pixel as an artistic device would not have evolved into a core component of the contemporary visual aesthetic now intrinsic to digital and new media art. The modern pixel aesthetic in pre-computer art is composed of three unique properties that are shared by its modern digital sibling. Those properties are founded in the science and mathematics of optics (including color and perception), geometry, and the mechanization of art making processes. But in order for the age of computers to be brought into the realm of art making there must be an accepted legitimacy by the art world. The birth and evolution of most art movements are typically not experienced in real-time. That is to say, in order for a new art movement to become instituted within a culture it requires time for it to be reviewed, studied, and critiqued before it can be embraced or legitimized. I assert that the pixel aesthetic in art practice has incubated sufficiently to be recognized as a legitimate artistic movement in its own right. Baumann observes that success in the art world generally relies on three factors: a change in cultural opportunity space, the institutionalization of resources and practices, and a legitimating ideology [13].

Figure 6. Vera Molnár. Untitled. 1969, Musée National D'Art Moderne Centre Georges Pompidou, Paris.

Hindrances to creative research must be overcome and a space free from the social-psychological connotations associated to conventional aesthetics [14] would be required in order for a new environment of digital art to get a foothold. The rapid development of early computing technologies proved to be an ideal opportunity space, while artists and computer scientists alike provided the experimentation that laid the groundwork for the institutionalization and ideology of this new aesthetic. Dietrich also goes on to say that it is the computer's non-humanness that can free art from the influences of the current art community, but unfortunately, the "art critics who pointed out the cool and mechanical look of the first results of computer art did not grasp the implications of this concept" [14]. One of the earliest pioneers of digital computer art was Vera Molnár (figure 6). Her computer-generated works in the late 1960s had produced forms that had previously not been observed in nature or in art institutions up to that time [14]. Much like Kelly and Richter, Molnár's early computer works make use of an aleatory approach to image placement, which contains the diagrammatic language at the heart of the pixel aesthetic and gives her work a similarly mechanized attractiveness to that of the early abstractionists. As the 1960s ushered in a new age of technology, there was a creation of many new arenas for artists to explore, still primarily based in electro-mechanical and analog based systems. It was the ability of the computer to replicate and perform routine programmable functions that was significant in the advancement of the computer as a viable artistic tool. As computer technology moved to digital based frameworks, the role of graphics and visual output truly came to the forefront and defined what the pixel aesthetic is today.

Survey of apophenia and the modern pixel in generative art

Now that a historical foundation is established, we can begin to explore how these seemingly separate histories, media, and formats have amalgamated to bring forth a unique and appealing visual language. Before I discuss the pixel's significance within generative art it is necessary to establish the criteria that make this particular aesthetic different from the multitude of practices that digital art is comprised of. Digital art has taken on many forms over the years. There are numerous subtypes of digital art; some examples include digital painting, photo manipulation, and music visualization. Generative art, one of these subtypes, is itself an umbrella for numerous sub-forms, and the use of apophenia/pareidolia and the visual experience of pixel data is inextricably tied to one-another. When we talk about pixels and pixel aesthetics we generally leap immediately to raster-based imagery as opposed to vector-based imagery, allowing the visual representations to retain their blocky grid-like nature. Therefore, the use of smoothing and/or interpolation filters is often discouraged especially when scaling is introduced. Further, we can combine this particular characteristic of the pixel with the psychological phenomena of pareidolia, a form of apophenia often related to the observation of familiar, recognizable objects in disassociated contexts, especially facial features in things such as clouds or rock

formations. Using the pixel as the vehicle we are able to explore how generative art is affected by our human perceptions and the rudimentary formation of the digital image. One additional theory that is also applicable is Arthur Koestler's notion of the *holon* [15]. A holon is described as something that is both *a part* and simultaneously *a whole*. The pixel is one of these holonic components, that is itself a single unit composed of smaller parts (binary data or color related values) that can exist on its own while simultaneously being a member of a larger collection of pixels that form an image.

One of the earliest artworks that satisfy these criteria is found in Leon Harmon's scientific exploration of perception and visual information [16]. When Harmon's study of image perception is viewed in conjunction with psychological studies of how color and patterns impact visual imagery [17-19], we see exactly how Harmon's research works within the context of pareidolia (Figure 7). In a sense, Harmon's digital exploration of how little information is needed to make a recognizable image is very much related to the minimal information we require to generate images from our stars. As a result of this exploration, the division, abstraction, and minimalization of the image to its most important components has most likely made Harmon the father of the modern photographic/digital mosaic.

The photographic mosaic is an art form that was introduced into the mainstream art world in the mid-1990s, and was made popular by computer scientists like Adam Finkelstein. In 1994, Finkelstein and Sandy Farrier created a mosaic of John F. Kennedy (Figure 8) from image segments of Marilyn Monroe. Since this time, there have been numerous computer scientists and artists alike that have developed processes and algorithms that attempt to optimally suggest the best arrangement of a subset of images to create a photo-mosaic, including several computer applications made for consumers that have moved the practice from the lab and studio into the average computer user's home. What makes photo-mosaics especially pertinent to this survey is that each 'pixel' of the larger image is represented by an entirely separate image. In this regard, the holon is explicit and consideration of the individual components is as critical as viewing the entire constructed image. However, it is the prevalence of this style of pixel-selection artwork that has become so accessible to the general public that, to some extent, has diluted the underlying creative process through its automation. The popularity of digital image mosaics has provided the entire population the ability to create incredible imagery with little to no artistic or technological background. However, without this particular mode of pixel-oriented construction I do not believe that the pixel would have continued to flourish and remain intrinsic to digital expression as it has. Photo-mosaics can be considered semi-generative (or pseudo-generative) in the sense that a finite subset of random image 'pieces' can be combined in a multitude of arrangements to produce many different images. If one were to create a mosaic image of randomly assigned smaller images then at some point recognizable images will inevitably become discernible.

Figure 7. Leon Harmon Mona Lisa, 1973. Scientific American, New York, NY.

Figure 8. Adam Finkelstein and Sandy Farrier Jfk-Mm. 1994. Xerox PARC Algorithmic Art Show, Palo Alto, CA

The idea that random objects can eventually construct meaningful images is exactly what Phil McCarthy's *Pareidoloop* does. *Pareidoloop* is a generative art application that combines genetic programming techniques with facial recognition software to randomly layer countless polygons upon one another until an identifiable face is generated (Figure 9). These portraits are fictional characters from the digital world, yet they are sometimes identifiable as individuals from our own reality. This is an intriguing concept that not only have we managed to create a face from random data, but an identifiable personality as well. As McCarthy points out, it is interesting how many of these portraits resemble old photographs of Einstein [20].

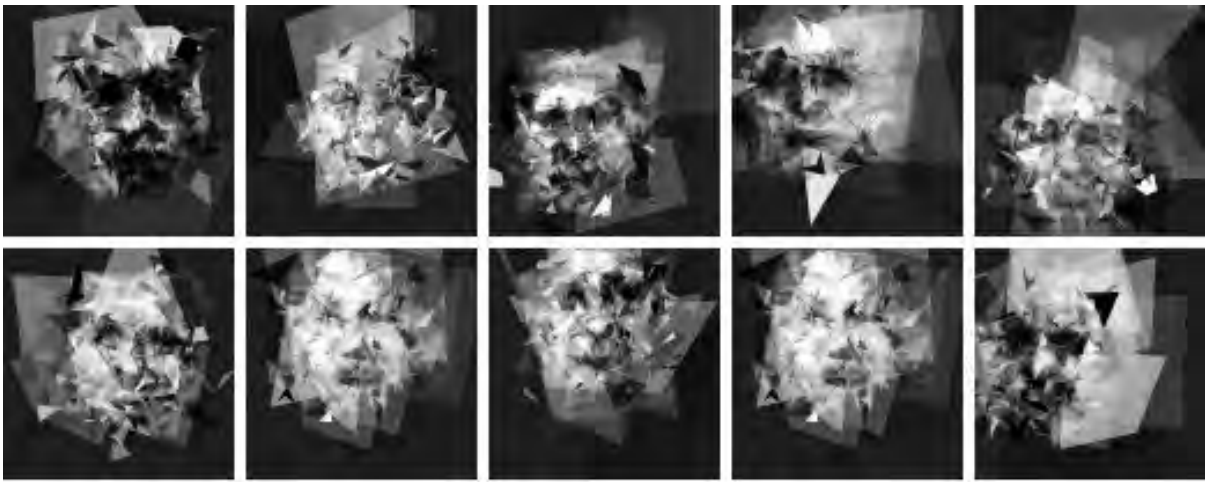

Figure 9. Phil McCarthy. Pareidoloop (portraits generated by Jon Corbett). October 12, 2013.

Our pareidolic tendency towards the heavens is ever evident today. Returning my focus back to our cosmos, I would like to draw attention to the modern convention of naming our celestial bodies, for example “Crab Nebula”, “Fireworks Galaxy”, and “The Witch’s Broom Nebula”. Their obvious inspirations from earthly objects leads to a theoretical exploration of celestial art generation. Artist Chris Keegan has produced pareidolic photo manipulations from deep space imagery taken by the Hubble Telescope. Keegan’s images give us a glimpse of what our universe could generate (Figure 10), and by extension demonstrate an opportunity for possible exploration in a generative art context.

Conceptually, both McCarthy’s and Keegan’s explorations are a look at where this evolutionary process of the pixel has arrived at; further, it begs the question, *what is next?*

Perhaps the next step is to move our apophenic predisposition into a three dimensional space with spatially distributed pixels. Perhaps putting ourselves *within* the heavens is the next step, not only visually seeking imagery, but experiencing the imagery as environment. Immersion in a three-dimensional light sculpture (like Squidsoup’s *Submergence* [21]) would be able to facilitate such an environment if the images produced through its apparatus were filled with floating fields of generated clouds.

a. **b.**

*Figure 10. Chris Keegan. **a** – Butterfly. 2010; **b** – Black Body. 2010.*

Conclusion

The combination of our apophenial nature and our compulsion to format imagery with blocks of information have recorded origins dating back thousands of years, from the star patterns used to navigate our planet, to the recognizable yet fictional characters found within the algorithms of modern computing. The role of pixel is crucial, whether we consider or are even aware of the historical context of its birth. The pixel, as the single most important element in a generative artist's toolbox, combined with the endless possibilities that perception affords, opens up an entire universe for future exploration.

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