

## On the Use of Geometric Elements in the Works of Laszlo Moholy-Nagy and Piet Mondrian

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### Cover Page Footnote

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# On the Use of Geometric Elements in the Works of László Moholy-Nagy and Piet Mondrian

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## Abstract

Working in overlapping artistic circles in the first half of the twentieth century, László Moholy-Nagy and Piet Mondrian had very different intentions for how their pieces would affect viewers. But while their aims differed dramatically, the individual techniques they employed were both rooted in a mathematical foundation. Moholy-Nagy used simple two-dimensional shapes, scaled repetition of those shapes, and variations in perspective to illustrate the potential benefits of machine technology to the common person. Mondrian, alternatively, limited the elements in his work to perpendicular lines, asymmetry, and a dedicated adherence to the plane in order to align his viewer's metaphysical state with an underlying universal spirit. In this article, we focus on the mathematical inspiration and general intentions behind two pieces from the two artists, an untitled collage by Moholy-Nagy and *Broadway Boogie Woogie* by Mondrian, in the context of their writings and other works.

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## 1. Introduction

Abstract art of the early twentieth century is a treasure trove for those interested in the intersection of mathematics and art. From the Cubists' experimentation with shape and perspective [2] to the Surrealists' fascination with the fourth dimension [9], art and mathematics intertwine in numerous ways during this period. In the first-year seminar *Math as Muse: Exploring the Relationship between Math and Art* (facilitated by KS and MR, taken by CL) at our institution, we spent significant time considering major artists of this period and their use of basic geometric elements. László Moholy-Nagy and Piet Mondrian were two such artists, particularly given Moholy-Nagy's desire to communicate through simple geometric shapes and Mondrian's belief in the mystical symbolism of horizontal and vertical lines.

While Moholy-Nagy has not received the same level of attention as Mondrian, the major retrospective *Moholy-Nagy: Future Present* [34] at the Solomon R. Guggenheim Museum, Art Institute of Chicago, and Los Angeles County Museum of Art (2016-2017) showcased his important and varied contributions to early twentieth century art. The timeliness of the exhibit and an internal grant from our institution gave us the opportunity to visit it during its residence in New York City; thus we were able to gather a great deal of discussion material about Moholy-Nagy for the seminar. Analysis of Mondrian's work was already a part of the core reading for the seminar [5]. In this article, the three of us consider the two artists together, aiming to highlight their common interest in moving humanity forward.

To be precise, we present here a comparative analysis of an untitled collage by Moholy-Nagy and *Broadway Boogie Woogie* by Mondrian, drawing on ideas developed in the context of the seminar. Figure 1 contains images of both pieces. Both artists used basic geometric elements to illustrate different directions for human progress. The former addressed the improvement of society at large through thoughtful use of modern technology, while the latter focused on aligning his viewer's metaphysical condition with an underlying universal spirit. These differences in artistic aims are illustrated through the following analysis of mathematical components in the two aforementioned pieces, along with related works and writings by the artists.

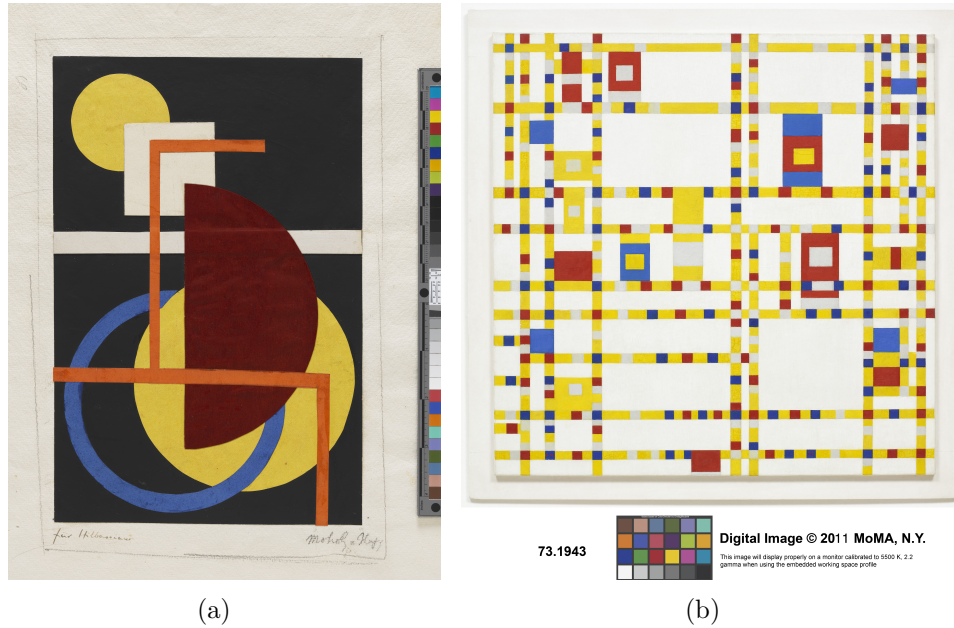


Figure 1: The two works of art under principal consideration in this paper: (a) László Moholy-Nagy, *Untitled*, 1920-1921, gouache and collage on paper, 24.45 × 16.19 cm, Los Angeles County Museum of Art ©[2017] Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York; (b) Piet Mondrian, *Broadway Boogie Woogie*, 1942-1943, oil on canvas, 127 × 127 cm, Museum of Modern Art, New York.

## 2. Backgrounds

László Moholy-Nagy (1895-1946) was a Hungarian abstract artist drawn to the emphasis of Constructivism on the role of art in moving society towards a more egalitarian model. In this context, Moholy-Nagy came to view human progress as dependent on the intelligent use of industry; he wrote in *Education and the Bauhaus* (1938) that technological advancement is “an indispensable factor in raising the standard of life” [19, page 345]. Working in Berlin in his mid-twenties, Moholy-Nagy circulated amongst leading artists of the time, including El Lissitzky and Theo van Doesburg, and experimented with various media. His undeniable talent and avant-garde aesthetic, along with his personal charm [32], earned him a teaching position at the Bauhaus in Weimer, Germany, from 1923 to 1928. A combination of personal politics at the school and the onset of World War II drove Moholy-Nagy to Holland, London, and finally Chicago. There, he founded the New Bauhaus, now the

Institute of Design at the Illinois Institute of Technology, in 1937. Throughout his career and specifically with *Untitled*, Moholy-Nagy incorporated his vision of a utopian future through the mathematical elements of simplified two-dimensional shapes, scaling, and perspective.

While Dutch artist Piet Mondrian (1872-1944) was formally trained in landscape painting, his association with philosopher M.H.J. Shoenmaekers and artist Theo van Doesburg pushed Mondrian toward abstract art [8]. His recognizable style of numerous intersecting horizontal and vertical lines, with primary colors filling a number of the resultant rectangles, is characteristic of the De Stijl movement he and van Doesburg pioneered. The two artists parted ways after World War I, and Mondrian spent the rest of his life honing and proselytizing Neo-Plasticism, the theory behind the De Stijl aesthetic. His six Neo-Plastic laws give instruction on the use of straight lines, right angles, asymmetry, proportion, and color in order to express a fundamental and universal spiritual force. Specific and individual statements of each Neo-Plastic principle appear in [25, 26] and elsewhere. Recognition of and subsequent alignment with these governing axioms were central to Mondrian's vision for human evolution. Mondrian spent the last years of his life in New York City, where he was enamored with the gridded city plan, which he saw as the physical embodiment of Neo-Plasticism [12]. His last completed piece, *Broadway Boogie Woogie*, is arguably the culmination of his life's work [3, 6], painted in New York a year before his death.

The two artists do not seem to have regarded each other highly, perhaps due to the very different paths they envisioned for human and artistic progress [4]. In a 1923 declaration of true Constructivist aims [11], Moholy-Nagy and others accused De Stijl artists of creating bourgeois art with a limited vision. Mondrian retorted in [27, page 129] that those who “are in favor of the progress of the mass and against the progress of the elite [are] against the logical march of human evolution”. Later in [27, page 129], he praised the “elite” as the “highest expression” of the masses, making them better able to understand his work. Despite his criticism, Moholy-Nagy was tasked with designing the covers of Mondrian's Bauhaus book *Neo-Plasticism* and van Doesburg's *Principles of Neo-Plastic Art*.<sup>1</sup> It is noteworthy that Moholy-

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<sup>1</sup> An image of the cover art for Mondrian's book may be found on <http://www.harvardartmuseums.org/art/217729>, while the cover artwork for van Doesburg's book

Nagy produced a quintessentially De Stijl aesthetic for van Doesburg's text, likely in opposition to his own views [16]. For his part, Mondrian considered Moholy-Nagy's New Bauhaus to be a deficient institution even though he sought a faculty position there, albeit as a means for leaving Europe on the brink of World War II [10, page 310]. Thus their drastically different philosophies seem to have contributed to a lack of fondness that spanned decades.

### 3. Formal Analysis

Common to both *Untitled* and *Broadway Boogie Woogie* is a color scheme dependent upon yellow accented with blue on a light gray background. The line segments in *Broadway Boogie Woogie* are composed of small rectangles in yellow, blue, red and gray. Two different shades of blue are discernible throughout the painting; the larger blue rectangles are a lighter hue than the smaller blue ones. Intersections of the line segments create large gray blocks that read as negative space. As with the distinct blues, two shades of gray are used: a lighter gray for the larger rectangles and a darker gray for the smaller ones.

The light gray in *Untitled* is used as a framing device while the substantial black rectangles create negative space and structure. Pencil marks on the gray border further designate an informal frame around the composition. An interesting spatial feature in *Untitled* is the arrangement of the blue circle and yellow disk; they appear to be interlocked instead of simply layered. While Moholy-Nagy does not use a truly red hue, his use of maroon and orange accents the composition in a similar manner to Mondrian's. Both elements in his collage provide the same injection of warmth as the red rectangles in *Broadway Boogie Woogie*. Moreover, the orange linear arrangement in the foreground of *Untitled* echoes Mondrian's right angles and contrasts with the curvature of the circles. Both artists delineate the separate geometric elements in their pieces through contrasting colors instead of dark outlines. This explains the use of two different shades of gray in *Broadway Boogie Woogie*, although the same does not apply to the blue pigments.

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may be viewed at <http://www.harvardartmuseums.org/collections/object/217420?position=0> (both were last accessed on January 24, 2019).

The colors in both pieces are deeply saturated. Because there is no use of shadow or light source, the visual weight and the impact of an individual form are determined by its area. This characteristic flattens the picture plane, less so in *Untitled* than *Broadway Boogie Woogie*. There, we see a handful of instances when a yellow or dark gray rectangle is encompassed by a contrastingly colored rectangle. To further accentuate the red, the yellow, the blues, and the grays, the square canvas floats on a larger square wooden panel painted white (not visible in Figure 1(b)). The vibrancy of the orange, yellow, and blue hues in *Untitled* are heightened against the black background. Consequently, the colored geometric elements appear to float within the negative black space.

At first glance, both pieces also appear extremely precise. The lines and curves seem to be painstakingly produced, almost as if the pieces were manufactured by machines. However, upon close inspection of *Broadway Boogie Woogie*, Mondrian's artistic process is evident with brushwork and slightly overlapping regions of color; in various sections of yellow, shades of red and blue peek out from behind. This is undoubtedly a result of his trial-and-error creative process [12]. In *Untitled*, adhesive stains are evident on the blue circle in particular. The flattened curvature of the large yellow circle, near the right border of the collage, reveals a human touch. The texture observed within the maroon semicircle indicates that Moholy-Nagy used a strip of paper to break a single black rectangle into two smaller pieces. These elements were likely unavoidable given the nature of the media, despite both artists' intention to remove themselves from their pieces [18, 27].

#### 4. Two-Dimensional Geometry

As seen in Figure 1, the basic two-dimensional shapes that pervade the works under consideration are rectangles and circles. Mondrian's *Broadway Boogie Woogie* is solely rectangular while both shapes are incorporated into Moholy-Nagy's *Untitled*. Their choices to use simplified geometric elements were reflective of the avant-garde at the time. Constructivists, led by Vladimir Tatlin amid the rise of Communism in Russia, considered pure geometric shapes to be accessible to all viewers and rejected objective painting as a hallmark of the elite. Their intent was to make art that could serve the common good [13]. Moholy-Nagy was heavily influenced by their ideology

and visual language. Reflecting on his career in “Abstract of an artist” (1944), Moholy-Nagy wrote [20, page 364]:

The so-called ‘unpolitical’ approach to art is a fallacy. Politics is taken here ... as a way of realizing ideas for the benefit of the community. ... Art may press for a socio-biological solution of problems just as energetically as social revolutionaries may press for political action. ... I believed that abstract art not only registers contemporary problems, but projects a desirable future order, unhampered by a secondary meaning, which the customary departure from nature usually involves because of its inevitable connotations. Abstract art, I thought, creates new types of spatial relationships, new forms, new visual laws — basic and simple — as the visual counterpart to a more purposeful cooperative human society.

Throughout his career, Moholy-Nagy coupled the Constructivist style with what he saw as the potential role industry could play in the creation of this ideal future. The untitled collage we consider here was completed quite early in the his working years but contains the themes of industry and advocacy for a classless society that Moholy-Nagy pursued until his death.

The organization of the simple shapes in *Untitled* elicits an industrial and mechanical feel in alignment with other early pieces of his. Elsewhere in “Abstract of an artist”, Moholy-Nagy writes [20, page 362]:

Coming from a farm in the agricultural center of Hungary, I was less intrigued with the baroque pompousness of the Austrian capital than with the highly developed technology of industrial Germany. ... Many of my paintings of that period show the influence of the industrial landscape of Berlin. They were not projections of reality rendered with photographic eyes, but rather new structures, built up as my own version of machine technology, reassembled from the dismantled parts.

In particular, the aforementioned blue circle and yellow disk, joined as they are, give the semblance of machine parts in motion. Further, the orange line segments mimic the shape of a mechanical arm, crane, or set of pipes. These





Figure 2: László Moholy-Nagy, *Y*, 1920/1921, gauche and collage on paper, 27.5 × 21.5 cm ©[2017] Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York.

elements are reminiscent of circular and linear components that appear in Moholy-Nagy's other work from the early 1920s, such as *Perpe*, *F in Feld* (*F in Field*) and *Y*. In these pieces, the circles explicitly depict wheels and gears. Moholy-Nagy pushed further into abstraction with *Untitled*, weakening the obvious connection to an industrial context, but the connotation is subtly preserved. Most tellingly, the arrangement of line segments in *Y*, from 1920-1921, depicts a drainage system in a very similar fashion to the orange line segments in *Untitled*; see Figure 2 above.

Regarding form, there are two rectangles that are essentially, if not exactly, squares in *Untitled*: a small light gray form in the upper left corner and the lower large black section containing the blue circle and yellow disk. The straight edges of the small gray square are starkly contrasted with the curvature of the small yellow circle layered under it. Additionally, the squares are void of color while the circular elements have primary hues. Moholy-Nagy discussed the use of squares in his essay "On the problem of new content and new form" (1922) [14, page 287]:

While a triangle set on any one of its angles or a trapezoid or an



irregular form has pronounced psychological effect by dint of its form, the square, being the most neutral form, is of consequence only as a bearer of color and creates least disturbance among the inner relationships of the colors.

The neutrality of the square shape is reinforced by the lack of dominant pigment. By extension, the smaller black rectangle and the grey rectangular frame preserve the impartiality of the squares in shape and color. All of these elementary components give *Untitled* structure and organization antithetical to a more complicated natural order. From the previous passage as well as Moholy-Nagy's reflection in [20, page 363], his use of familiar two-dimensional shapes was largely motivated by their subservient role to the relationships created between colors. The combination of neutral squares and the muted colors that fill them does indeed propel the viewer's eye toward the brightly contrasting pigments instead.

Taking *Untitled* together with concurrent pieces, it is clear that Moholy-Nagy was lifting up industrial elements to a level worthy of artistic efforts and honoring their importance in the lives of one and all. Krisztina Passuth, a scholar of Moholy-Nagy and the avant-garde of his time [31], expressed this sentiment in [32, page 26]:

Moholy-Nagy really believed in machines. He believed that with the help of the new machine civilization, humanity could embark upon a new era. For this reason, he invested machinery parts with heroism and a monumental power of expression appropriate to the heralding of the new age.

He described technology as the great equalizer in [15, page 185]: "Before the machine, everyone is equal — I can use it, so can you — it can crush me and the same can happen to you. There is no tradition in technology, no consciousness of class or standing. Everybody can be the machine's master or its slave." Industry, then, was the key to Moholy-Nagy's vision of human progress so long as it was not used to systemically exploit the common worker.

Mondrian employed a similarly small visual vocabulary in all of his abstract works, including *Broadway Boogie Woogie*, but did so without any of Moholy-Nagy's subtle references to human life. His fourth Neo-Plastic law states

that line segments arranged perpendicularly are the ideal artistic expression of the tension between intrinsic universal forces held in equilibrium [26]. Specifically, the ninety degree angle created by intersecting perpendicular lines embodies what Mondrian called “the movement of life” [25, page 210]: the dynamic balance of opposite and complementary energies akin to the yin/yang symbol in ancient Chinese philosophy and the hexagram in pagan communities [5, 22]. Given the physical constraints of the human body, lines parallel to the specifically vertical and horizontal orientations of the canvas fully connote the symbolism of the resulting right angle when they intersect [1]. Thus Mondrian excluded oblique lines in his work, even when he rotated the canvases themselves by forty-five degrees as in his Lozenge series; see, for instance, Figure 3. After limited experimentation<sup>2</sup> and thoughtful con-

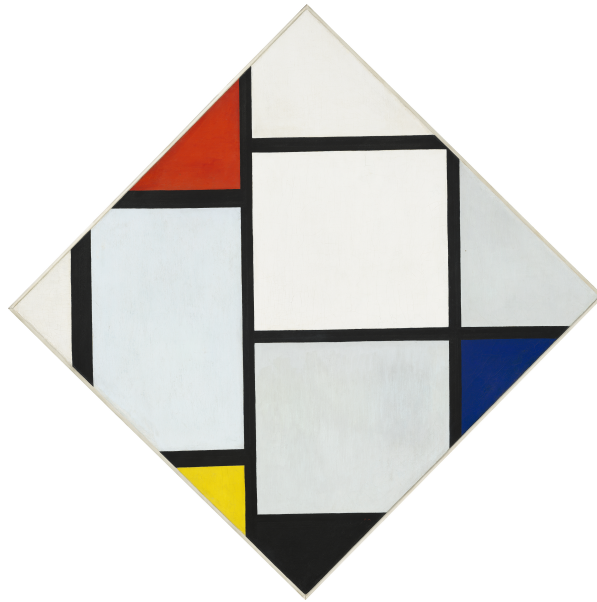


Figure 3: Piet Mondrian, *Tableau No. IV; Lozenge Composition with Red, Gray, Blue, Yellow, and Black*, c. 1924/1925, oil on canvas, 142.8 × 142.3 cm, Courtesy National Gallery of Art, Washington ©[2017] Mondrian Trust.

<sup>2</sup> See, for instance, his 1918 work, *Composition with gray lines*, a copy of which may be viewed at <https://www.gemeentemuseum.nl/nl/collectie/compositie-met-grijze-lijnen> (last accessed on January 24, 2019), and his 1919 work, *Composition in Black and Gray Composition with Grid 4 (Lozenge)*, a copy of which may

sideration, Mondrian decidedly rejected line segments in any nontraditional orientations [25, page 210] (emphasis his):

[I]n Neo-Plastic art the essential question is not of vertical or horizontal, but of the perpendicular position — and the relationship thus obtained. For it is this relationship that express the immutable in contrast to the mutable in nature. Very fine things can therefore be created by turning this relationship to the oblique. The oblique is naturally relative and depends upon our position or the position of things. But despite all relativism, man’s eye is not yet free from his body. Vision is inherently bound to our normal position. Only the mind can know anything of the forth [sic] dimension and detach itself from our poor physical body! As men, we must deal with *man’s equilibrium*; if we upset it we create nothing! Plastic expression is determined by our physical and spiritual equilibrium.

In the same vein, intersecting curves can tangentially produce a right angle, but they would inhibit a more profound recognition of the equilibrium Mondrian sought to convey [27]. Such curves would also be less abstract and more naturalistic, introducing some level of subjectivity into the artwork and detracting from the universal truth central to Neo-Plasticism [24].

The grid-like arrangement of perpendicular lines naturally creates rectangles throughout *Broadway Boogie Woogie*. In his essay titled “Toward the true vision of reality” (1941), Mondrian described the rectangles in his work as unintentional byproducts of such a structure: “In fact, rectangles are never an aim in themselves but a logical consequence of their determining lines, which are continuous in space; they appear spontaneously through the crossing of vertical and horizontal lines” [29, page 339]. Inadvertent as they are, he insisted that the rectangles and the lines that generate them are the purest and uniquely suitable forms for abstract art. These particular geometric elements naturally include the right angles that represent the underlying universal principle of dual opposition. Additionally, the individual rectangles are able to easily construct a larger whole. Similar to building blocks, the

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be viewed at <http://www.philamuseum.org/collections/permanent/51069.html> (last accessed on January 24, 2019).

rectangles in Mondrian's artworks create compositions that are greater than the sum of their parts.

Mondrian's third and fifth Neo-Plastic laws dictate that the individual elements in a piece must be considered in relation to the larger work [26]. Relationships and rhythm arise through the multiplicity of line segments and rectangles in a single composition. Just as the combination of separate rooms create buildings that produce a singular thriving city, the rectangles of varying sizes and colors in *Broadway Boogie Woogie* imbue the canvas with a unifying and pulsating energy. A viewer can only recognize this underlying vitality when the smaller components lose their individuality in service to the whole. As such, Mondrian expressly prohibited geometric forms that would preserve their distinctiveness. A particular example is a circle, which he considered to be self-contained and unable to create the visual relationships that are imperative to his theory [28]. He writes in "The necessity for a new teaching in art, architecture, and industry" (1938) that "The greatest openness is produced by mutually intersecting perpendicular lines, for these never meet, never become closed" [28, page 313]. The interlocking disk and circle in Moholy-Nagy's *Untitled* simultaneously support and refute Mondrian's argument. The circumferences, particularly when set against the black background, do emphasize their separateness from other elements in the collage. Simultaneously, their interconnected positions create a visual relationship that lends a feeling of movement to the work.

Awareness and contemplation of transcendent equilibrium within a singular whole were the keys to human progress in Mondrian's grand vision. By expressing the spiritual essence of all existence in his art, Mondrian believed that his viewers could model their lives, and hence society at large, on the universal truth he conveyed. Mondrian wrote in 1919 of Neo-Plasticism [23, page 80] (emphasis his):

But the task of art is to express the *superhuman*. It is intuition. It is pure expression of the incomprehensible force that is universally active and that we can therefore call *the universal*. . . . Only *conscious* man can purely mirror the universal: he can *consciously* become one with the universal and so can *consciously* transcend the individual.

Purposefully, then, we would lose our individual selves in the encompass-

ing universal spirit in the same way that the smaller rectangles in *Broadway Boogie Woogie* join together in the larger composition. Mondrian ended his manifesto “General principles of Neo-Plasticism” (1926) by proclaiming that the equilibrium he sought to reveal “annihilates individuals as particular personalities, and creates a future society as *true unity*” [26, page 215] (emphasis his). Recognizing the equilibrated whole was the first step in the evolution of human consciousness toward Mondrian’s utopian vision.

## 5. Balance through Asymmetry and Scaling

Neither of the pieces in Figure 1 comes close to being described as a symmetric composition; on the contrary both successfully achieve a visual equilibrium through their deviations from symmetry. In the vast majority of Mondrian’s work, including *Broadway Boogie Woogie*, small areas of saturated primary colors counter large neutral areas within an asymmetric grid. Inside the colored line segments of *Broadway Boogie Woogie*, color groupings are reiterated, such as the blue-yellow-red-yellow-blue arrangement seen three times horizontally in the third quadrant. But the spacing between non-yellow squares in this pseudo-pattern decreases unevenly through its vertical recurrence, thereby creating a sense of movement in an unsystematic way.

Larger elements in *Broadway Boogie Woogie* also contribute to its energetic balance. From the top of the canvas to the bottom, there is a continuous thin strip of yellow, blue, red, and dark gray rectangles that sits slightly to the right of the center. Similarly, there are two continuous thin strips, from left to right, above and below the center. Through the placement of these particular components, Mondrian purposefully left the center of the work in negative space and prohibited any potential axes of symmetry from being established on the square canvas. Moreover, the off-center location of the aforementioned vertical strip is telling in its deliberateness; by avoiding the center, Mondrian “presuppose[s] its presence” [1, page 215] and highlights the fundamental role of asymmetry in his theory.

The sixth Neo-Plastic law requires that repetition and symmetry be prohibited [26] so as not to inhibit dynamic equilibrium, which, in the context of Mondrian’s paintings, is precisely the lively visual balance of color and size described above. It depicts the tension between commensurate forces in competition rather than a sense of calm, restful, and still energy that can be

translated visually through symmetry and repetition of form [27]. By way of example, a monochromatic piece from Josef Albers' *Homage to the Square* series (1950-1954) achieves stability through the symmetric organization of the repeated geometric shape. Such a static balance is precisely what Mondrian eschewed in *Broadway Boogie Woogie* through his use of asymmetry and irregularity.

The colored lines in *Broadway Boogie Woogie* additionally inject palpable energy into the piece. Mondrian recognized that the black lines ubiquitous in his previous work diminished his intended effect. In a 1943 letter to curator James Johnson Sweeney, the same time at which he was completing *Broadway Boogie Woogie*, the artist made the following observation regarding static and dynamic equilibria [30, page 357]:

Many appreciate in my former work just what I did not want to express, but which was produced by an incapacity to express what I wanted to express — dynamic movement in equilibrium. But a continuous struggle for this statement brought me nearer.

The black lines would inadvertently act as scaffolding that secured the colored rectangles in a fixed balance. In contrast, *Broadway Boogie Woogie* is a lively display of primary colors flashing in disparate rhythms against the subdued background.

Through its asymmetry and vibrancy, *Broadway Boogie Woogie* is a celebratory depiction of the form and energy of New York City, held up for others to imitate. The assorted individuals living and working in the city all contribute to the beating heart of the singular metropolis, exemplifying Mondrian's central tenets of equilibrium, wholeness, and dynamism. In coordination with a 1995 retrospective at the Museum of Modern Art in New York City, curator Beatrice Kernan reflected on Mondrian's relationship with the city [12, page 7]:

Mondrian's abstract art found resonance in the most modern of metropolises. His utopianism celebrated the image New York presented him, an image teeming with diversity harmonized in a vibrant, coherent whole. He delighted in the city's angular regularity — its soaring verticals and unyielding grids, its glistening modular fenestration and nocturnal geometries of light.

In New York at mid-century the most resolute modern abstractionist found a spiritual home.

From his privileged position, Mondrian recognized some part of his vision for human progress in New York City's rectangular prisms, or "intersection of planes" [28, page 317], brimming with life. In a stark contrast, Moholy-Nagy denounced such a landscape as a bastion of capitalism [14, page 287]:

We need the machine. We need it, free from romanticism. The skyscraper really is an unhealthy construction not to be emulated, but we can stand up for funiculars and cranes and water towers which are the ingenious creations of the same spirit of construction. The absolute value of a piece of work cannot be prejudiced by the extortionist, corrupt practices of the society in question. It is not the machine that is bad, but today's social order.

The scene that inspired Mondrian with hope for the future was exploitive and counterproductive to the common good in Moholy-Nagy's view. Both agreed that modern industrial and technological advancements should be used to further humanity but with vastly different philosophies at heart.

Despite such a chasm between them, Moholy-Nagy similarly rejected any sense of symmetry in *Untitled*. He achieved a visual equilibrium mainly through scaled repetition of particular shapes. Repeated forms include the two yellow disks, the small light gray square echoed by the larger off-white paper that is itself part of the composition, and the large black rectangles that segment the entire collage into two parts. The specific dimensions and positions of the scaled black rectangles and yellow disks prohibit an axis of symmetry or a central focal point from being established. The deliberate asymmetry, through size and placement, creates a tense visual force [1] in contrast to the vivacious energy in *Broadway Boogie Woogie*. Moreover, there is a noticeable sense of familiarity between the upper and lower portions of *Untitled* that serves as a counterbalance to the unassociated orange line segments and maroon semicircle. In a 1982 exhibition catalogue [33] which included *Untitled*, Kate Steinitz wrote that these orange linear elements are central to the precarious visual balance of the collage. They are thin, unbroken, and unify the two dense rectangular regions that otherwise divide the work.



Figure 4: László Moholy-Nagy, *EM 3 (Telephone Picture)*, 1923, porcelain enamel on steel,  $24 \times 15$  cm, Museum of Modern Art, New York ©[2017] Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York.

Scaled motifs are common throughout Moholy-Nagy's work; a particular case is especially well documented [20]. In 1922, just after Moholy-Nagy finished *Untitled*, he ordered five paintings from a sign factory; by telephone, he and the factory supervisor used graph paper to convey the artist's various designs. One of them, depicted in *EM 1-3 (Telephone Picture)*, was produced in three different rectangular sizes, scaled both vertically and horizontally by an approximate factor of 2. Figure 4 shows the smallest of these, *EM 3 (Telephone Picture)*. Recalling the process, Moholy-Nagy wrote [20, page 381]:

One of the pictures was delivered in three different sizes, so that I could study the subtle differences in the color relations caused by the enlargement and reduction. . . . [M]y belief is that mathematically harmonious shapes, executed precisely, are filled with emotional quality, and that they represent the perfect balance between feeling and intellect.

Extrapolating to *Untitled*, the same balance is achieved through the scaled repetition of circles and rectangles. Highlighted against the dark background, the repeated straight edges connote intellectual structure at varying scales



while the circles' curvature and pigments feel dynamic and creative. The maroon semicircle combines these seemingly disparate elements into a complementary balance.

By using scaling effects in his *Untitled, EM 1-3 (Telephone Pictures)*, and elsewhere, Moholy-Nagy achieved visual balance between opposing forces and highlighted the use of industry in creating artwork for mass consumption. The artist's creativity generates a design while machines efficiently produce it in various sizes and media. As such, industrial technology is central to Moholy-Nagy's vision of art reaching and benefiting the masses. At the end of his life, he summarized the impact of this artistic and technological synthesis, in [21, page 360]:

The designer today has a political and sociological responsibility which is founded in mass-production. What he designs and how he designs it will influence the lives of millions of people. A good designer has to know where he came from historically and where we are going politically. The times of the ignorant specialist are over. It is up to industrial design organizations to stimulate this feeling of enhanced responsibility in a world of pre-fabricated values.

Thus societal advancement can be directed by the thoughtful integration of art and industry, instilling in people the egalitarian message to which Moholy-Nagy was devoted.

## 6. Perspective, or Lack Thereof

By virtue of the medium of collage, *Untitled* has an intrinsic three-dimensional depth through the layering of separate pieces. This is particularly obvious with the outline of the white paper strip that sits between the two black rectangles under the maroon half-disk. The layout of the blue circle and large yellow disk creates further spatial effects as the viewer reads a portion of the blue circle as being behind the yellow disk and vice versa. Additionally, the thin orange line segments in the foreground float above the more substantial shapes while anchoring them together. Steinitz observed that the half-disk frequently appears in Moholy-Nagy's work as a "device that interact[s] with

rhomboid lines to create compositional depth” [33, page 87]. The contrast of bright and dark pigments also contributes to a sense of depth as the light colors advance out of the plane and the dark colors recede into it [33].

Spatial depth and tension in *Untitled* are clearly deliberate effects as evidenced through Moholy-Nagy’s writings. He described Berlin’s industrial landscape around 1920 in the following passage from “Abstract of an artist” [20, page 362]:

On my walks I found scrap machine parts, screws, bolts, mechanical devices. I fastened, glued and nailed them on wooden boards, combined with drawings and painting. It seemed to me that in this way I could produce real spatial articulation, frontally and in profile, as well as more intense color effects.

It is a short jump from this description to *Untitled*, created during the time the artist described above, with its layers and scaled elements expressing some semblance of three-dimensionality. Passuth noted that Moholy-Nagy’s use of “complex relationships between planes . . . and the distinctly ‘Moholyian’ interpretation of intersecting planes and axes” are apparent particularly in his collages; the elementary geometric shapes “stand out clearly and with great plasticity against their backgrounds” [32, pages 24–25].

Moholy-Nagy’s enduring interest in spatial articulation, with or without relying on linear perspective, is evident in much of his work. The painting *K VII* from 1922, shown in Figure 5(a), is a model of linear perspective; the viewer can discern pale line segments that connect vertices of the front motif with the corresponding vertices of the smaller repeated image and that converge to a vanishing point in the top right corner of the canvas. In the photographic series *Dolls*, *The Schlemmer Girls*, and *Oskar Schlemmer, Ascona* from 1926 (see Figure 5(b)), Moholy-Nagy turns linear perspective into the very subject of his and the viewer’s attention. The classic perspectival grid of the Renaissance is recreated by the fence on the left of each image, and its shadow is distorted as it falls on the various human figures. These striking line segments and curves emphasize the failure of linear perspective to represent the human form [7].

Most interesting, as examples of Moholy-Nagy’s perspectival experiments, are his photomontages — photographs of paper collages he made using mag-

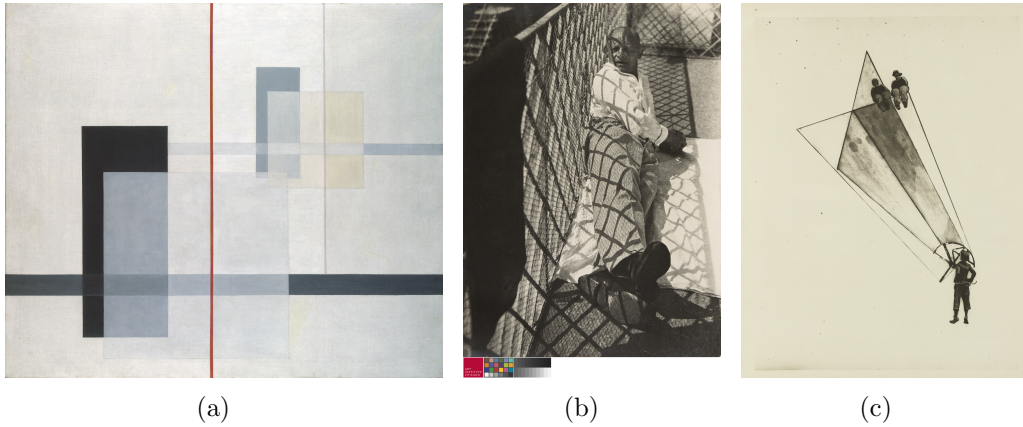


Figure 5: Explorations in perspective by László Moholy-Nagy: (a) *K VII*, 1922, oil paint and graphite on canvas,  $115.3 \times 135.9$  cm ©[2017] Tate, London and Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York; (b) *Oskar Schlemmer, Ascona*, 1926, gelatin silver print,  $29.2 \times 21.2$  cm, Art Institute of Chicago ©[2017] Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York; (c) *City Lights*, c. 1928, gelatin silver print,  $30.2 \times 23.5$  cm, The J. Paul Getty Museum, Los Angeles ©[2017] Estate of László Moholy-Nagy/Artists Rights Society/ARS, New York.

azine and newspaper images — in which he reverses the components of linear perspective so that larger objects are in the background, smaller objects are in the foreground, and the vanishing point lies outside the picture plane, in actual space with the viewer. Some example works of such perspectival experiments include *Die Lichter der Stadt (City Lights)*, c. 1926 (see Figure 5(c)), and *Kinetisch Konstruktives System: Bau mit Bewegungsbahnen für Spiel und Beförderung (Kinetic Constructive System: Structure with Moving Parts for Play and Conveyance)*, from 1928. The characteristic sense of space in these pieces is one that protrudes out of the photograph and into the viewer's realm. Reverse perspective was a means by which many avant-garde artists in the 1920s, Moholy-Nagy and El Lissitzky among them, further distanced themselves from representational art and challenged a viewer's detachment to a piece [7].

In *Painting and photography* (1932), Moholy-Nagy connected his interest in how the eye perceives the world and his ideal future society via modern advancements in photography. He saw his role, and his works challenging established spatial norms, as helping viewers train their sense of vision for a

classless future society [17, page 318-319]:

Optical works are one of the unconscious, unintentional educational tools with which we are trying to prepare a form of consciousness appropriate for the society of the future. . . . The capitalist motto of ‘profit above all’ turns the machine against man. This has already caused irreparable damage; generations have become enfeebled in their biological functions. The class struggle offers a way, a very effective way, of eliminating the mistakes of the capitalist system, thereby improving the organic conditions of life. But there are other ways as well, which are less conscious, but which have their aim to inform man — not so much through his intellect as through experience (the five senses) — about what he will need to rebuild his life after the partial or total collapse of the present system. Art is that unconscious preparation, the education of man’s subconscious.

In this context, Moholy-Nagy’s ambiguous sense of depth in *Untitled* is essential to his vision of human progress. The viewer’s optical sense is implicitly honed by considering the contradictory spatial elements in the piece: the recession of the yellow disks, the interlocking blue circle and large yellow disk and protruding layers of the collage.

Contrasting with Moholy-Nagy’s keen interest in perspective, Mondrian outright rejected any sense of three-dimensionality in his work. He declared in [22, page 29]:

[I]t is painting’s unique privilege to express relationships *freely* — in other words, its means of expression (through consistent and thorough transformation) allow extreme opposites to be expressed as the pure relationships of *position*, without assuming form, or even the appearance of form (as in architecture), through enclosure. In painting the dualities of relationship can be placed in juxtaposition to one another (on one plane), which is impossible in architecture or sculpture. Thus painting can indeed be the most purely ‘plastic’.

Perpendicular lines and the right angle are fundamental two-dimensional components of Neo-Plastic theory. Extending the intersection of lines to

the crossing of planes obfuscates the central relationship between opposite entities. Thus, even two-dimensional representations of three-dimensional objects do not appropriately convey the principles of Neo-Plasticism.

In *Broadway Boogie Woogie*, there is a misleading opportunity for viewers to discern a shallow depth; several rectangles appear to be layered on top of others with contrasting colors. Instead of creating physical depth through layering, as in *Untitled*, the saturated primary colors of the outer rectangles accentuate the flatness of the plane, creating a frame around the inner rectangles. Shadows or tone-on-tone variations that would convey a hint of depth are conspicuously missing from *Broadway Boogie Woogie*. This flattening effect is echoed by the wooden board on which the canvas hangs.

Mondrian's strong commitment to two dimensions was born out of a growing interest in nontraditional color schemes and the Cubists' revolutionary depiction of volumes [24]. The artist's evolution from landscape painting with perspective to abstract painting dedicated to the canvas plane is demonstrated through his paintings of trees around 1910. In Figure 6 on the next page, we provide four examples of trees depicted in various levels of abstraction, starting with *The Red Tree* (1908-1910). The tree itself is quite faithfully rendered but the color scheme is an early exploration of what Mondrian described as "denaturalization" in [25, page 211]. The transformative influence of Cubism on Mondrian is apparent in *Gray Tree* (1911) and *Blooming Apple Tree* (1912). Particularly in the latter of these is the appearance of vertical and horizontal line segments that represent the tree's structure. The artist's continued foray into total abstraction is documented in *Oval Composition with Trees* (1913), where there is a multitude of connected vertical and horizontal line segments in addition to an emphasis on the right angles created by them. The canvas itself is rectangular but painted to accent the oval center. As in *Broadway Boogie Woogie* years later, the framing device further accentuates the two-dimensionality of the composition.

Dedicated to the plane, Mondrian and his associates "believed that painting could provide a kind of diagram for a broader restructuring of the environment" in the physical sense, that is, via city life [6, page 11]. Mondrian hoped that a metropolis, in general, could exemplify a space in an ideal world motivated "entirely by spiritual, cosmic, what we would call transcendental concerns. And so what's 'plastic' is the ability that one has to create the future out of one's desire for perfection or for progress" [6, page 11]. Reflect-



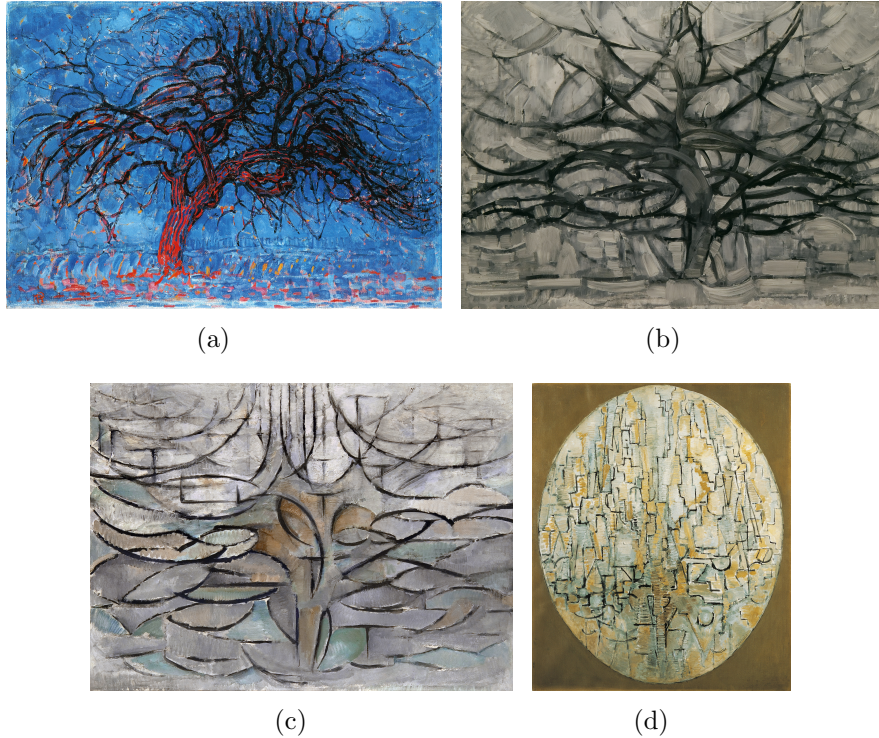


Figure 6: Explorations in abstraction by Piet Mondrian: (a) *The Red Tree*, 1908-1910, oil on canvas,  $99 \times 70$  cm, Gemeentemuseum The Hague ©[2017] Mondrian Trust; (b) *Gray Tree*, 1911, oil on canvas, 78.5 cm in height, Gemeentemuseum The Hague ©[2017] Mondrian Trust; (c) *Blooming Apple Tree*, 1912, oil on canvas,  $78.5 \times 107.5$  cm, Gemeentemuseum The Hague ©[2017] Mondrian Trust; (d) *Oval Composition with Trees*, 1913, Stedelijk Museum, Amsterdam ©[2017] Mondrian Trust.

ing on the particular potential of architecture to create such a future world, Mondrian conveyed his ultimate hope for humanity in [25, page 211-212] (emphasis his):

Physical and spiritual happiness — prerequisite for health — will be furthered by equilibrated oppositions of relationships of proportion and color, matter and space. The creation of a sort of Eden is not impossible if there is the will. . . . And man? Nothing in himself, he will be part of the whole; and losing his petty and pathetic individual pride, he will be happy in the Eden he will have *created*!

Guided to this Eden through Mondrian's planar expressions of the underlying spirit, we would no longer be bound by our own personal versions of life and existence; rather, our collective consciousness would acknowledge the abstract universal force that binds us together and we would act accordingly.

## 7. Summary

Moholy-Nagy and Mondrian both considered abstract art, and its elementary mathematical vocabulary, to be a means of communal change, but they pursued drastically different philosophical and artistic goals in their works. The ability of art and industry to foster social equity was central to Moholy-Nagy's work over the course of his career. On the other hand, Mondrian developed his artistic theory to further the spiritual unity of humankind. Simple geometric forms were inspired by visions of machine technology and universal principles. Symmetry was intentionally eschewed by both artists to capture dynamic tension between opposite and yet complementary entities. Three-dimensional depth was rigorously investigated in relation to human sight or flatly renounced in favor of the metaphysical purity of the plane. Notwithstanding their differences in style and aim, both men made important and lasting contributions to mathematically inspired art.

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## References

- [1] Rudolf Arnheim, *The Power of the Center: A Study of Composition in the Visual Arts, the New Version*, University of California Press, Berkeley CA, 1988.
- [2] Guillaume Apollinaire and Dorothea Eimert, *Cubism*, Parkstone International, New York, 2014.

- [3] Carel Blotkamp, *Mondrian: The Art of Destruction*, Harry N. Adams, New York NY, 1995.
- [4] Y. Bois, “Mondrian and the theory of architecture”, *Assemblage*, Number 4 (October 1987), MIT Press, Cambridge MA, pages 103–130.
- [5] Paul A. Calter, *Squaring the Circle: Geometry in Art and Architecture*, John Wiley, Hoboken NJ, 2008.
- [6] John Elderfield and Kay Larson, “Mondrian at MoMA. An interview with John Elderfield”, *MoMA* Number 20 (Autumn 1995), Museum of Modern Art, New York NY, pages 6–13.
- [7] Devin Fore, *Realism After Modernism: The Rehumanization of Art and Literature*, MIT Press, Cambridge MA, 2012.
- [8] Lynn Gamwell, *Mathematics + Art: A Cultural History*, Princeton University Press, Princeton NJ, 2016.
- [9] Linda Dalrymple Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, Princeton University Press, Princeton NJ, 1983.
- [10] Harry Holtzman and Martin S. James, editors, *The New Art - The New Life: The Collected Writings of Piet Mondrian*, Da Capo Press, New York NY, 1993.
- [11] Ernő Kállai, Alfréd Kemény, László Moholy-Nagy, László Péri, “Manifesto”, 1923, republished in and available on pages 288–289 of [31].
- [12] Beatrice Kernan, “Mondrian at MoMA. Mondrian’s New York years: A visual celebration of the city and Boogie-Woogie’s syncopated beat”, *MoMA* Number 20 (Autumn 1995), Museum of Modern Art, New York NY, pages 7–13.
- [13] Christina Lodder, *Russian Constructivism*, Yale University Press, New Haven CT, 1983.
- [14] László Moholy-Nagy, “On the problem of new content and new form”, 1922, republished in and available on pages 286–288 of [31].



- [15] László Moholy-Nagy, “Constructivism and the proletariat”, 1922, republished in *Moholy-Nagy*, edited by Richard Kostelanetz (Praeger, New York NY, 1970), pages 185–186.
- [16] László Moholy-Nagy and Alfréd Kemény, “Dynamic-constructive system of forces”, 1922, republished in and available on page 290 of [31].
- [17] László Moholy-Nagy, “Painting and photography”, 1932, republished in and available on pages 318–319 of [31].
- [18] László Moholy-Nagy, “From pigment to light”, 1933, republished in and available on pages 323–326 of [31].
- [19] László Moholy-Nagy, “Education and the Bauhaus”, 1938, republished in and available on pages 344–348 of [31].
- [20] László Moholy-Nagy, “Abstract of an artist”, 1944, republished in and available on pages 360–364 and 381–383 of [31].
- [21] László Moholy-Nagy, “Art in industry”, 1947, republished in and available on pages 357–360 of [31].
- [22] Piet Mondrian, “The new plastic in painting”, 1917, republished in and available on pages 27–74 of [10].
- [23] Piet Mondrian, “Dialogue on the new plastic”, 1919, republished in and available on pages 75–81 of [10].
- [24] Piet Mondrian, “The new plastic expression in painting”, 1926, republished in and available on pages 202–204 of [10].
- [25] Piet Mondrian, “Home-street-city”, 1926, republished in and available on pages 205–212 of [10].
- [26] Piet Mondrian, “General principles of Neo-Plasticism”, 1926, republished in and available on pages 213–215 of [10].
- [27] Piet Mondrian, “Plastic art & pure plastic art”, 1937, republished in *Modern Artists on Art: Ten Unabridged Essays*, edited by Robert L. Herbert (Prentice-Hall, Englewood Cliffs NJ, 1964), pages 114–130.

- [28] Piet Mondrian, “The necessity for a new teaching in art, architecture, and industry”, 1938, republished in and available on pages 310–317 of [10].
- [29] Piet Mondrian, “Toward the true vision of reality”, 1941, republished in and available on pages 338–341 of [10].
- [30] Piet Mondrian, “An interview with Mondrian”, 1943, republished in and available on pages. 356–357 of [10].
- [31] Krisztina Passuth, editor, *Moholy-Nagy*, Thames and Hudson, New York NY, 1985.
- [32] Krisztina Passuth, “László Moholy-Nagy and the international avant-garde”, *Hungarian Studies Review*, Volume **37** (2010), pages 21–27.
- [33] Kate Steinitz, *Art and Collection: Avant-Garde Art in Germany in the 1920s and 1930s*, California State College, San Bernardino CA, 1982.
- [34] Matthew S. Witkovsky, Carol S. Eliel and Karole P. B. Vail, editors, *Moholy-Nagy: Future Present*, Art Institute of Chicago, Chicago IL, 2016, pages 21–36.